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The Operation of the Simplon Tunnel Railway.

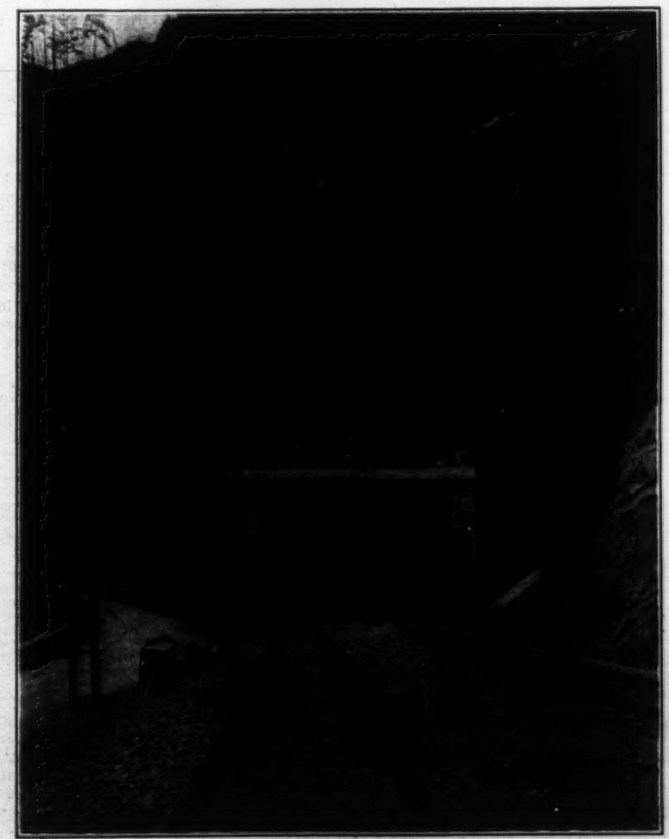
[Contributed.]

During the past year such changes have been made in the administration and operation of the Simplon tunnel line that it is now under a permanent management.* The Swiss Federal Railways have taken over the line at the end of the trial operating period of Brown Boveri et Cie., which firm had furnished the electrical equipment. Up to this time only two locomotives designed for use on the Simplon line had been in use, although two more were being built and two Ganz locomotives were borrowed from the Italian Valtellina line.† The two new Simplon locomotives are in regular operation, and as their design is much different from the earlier ones a brief comparison seems worthy of record.

FIRST LOCOMOTIVES. — The first two locomotives built are of a five-axle bogie type, three of the axles carrying drivers. Two three-phase motors are mounted between the three driving axles and both drive the middle axle by a bar which couples them together as shown in Fig. 2. To allow some vertical displacement of the motor driving bar, the wheel bar is fitted with a vertically slotted bearing. The locomotives were designed for two running speeds, of 21 and 42 mi. per hour.

The motors on this older type of locomotives were designed for a normal load of 450 HP. on 2,700 to 3,300 volts, three-phase, 16-cycle current, running at the higher speed and 390 HP. on the slower speed. It can be overloaded continuously about 28%. The two running speeds are obtained by changing the number of poles of the electrically revolving field. For this pole changing, the stator winding has six leads coming from the field windings. By a comparatively simple switch device the field winding can be connected to give either 16 or 8 poles, so that the rotor takes a speed of either 112 or 224 r. p. m. The rotor carries six collector rings and starting resistances are put in the rotor circuit to limit the current and speed. These resistances, one set to each motor, are placed in the two ends of the locomotive and are grids of a special high-resistance metal. Doors in the locomotive end make it easy to remove the grids, these sliding in horizontal grooves. Small motor-driven fans, placed in the rotor circuits, cool the resistances. By so connecting in the fans, when the resistances are in use the fans are running and when the motor is either at full speed or idle the fans are automatically deprived of current, as the resistance carries none.

The locomotive is operated by a compressed-air controller. One lever is for the reversing switch; another lever is for the pole changers, and a hand-wheel operates the starting resistances. The first two operations are through pneumatic motors. The reversing switch is a wooden cylinder in an oil bath and carries copper contacts which engage one or the other of two sets of contact fingers, according to the direction desired. The pole changer is a similar cylinder and is similarly operated. The hand-wheel shaft has a chain drive which drags a rider over fixed contact bars. The rider and bars are mounted directly beside the resistance grids.



PORTAL OF THE SIMPLON TUNNEL AT ISELLE, ITALY.

The current from two phases is taken from the two overhead wires and from the third rail for the third phase. The circuits from the bow trolleys include, in order, the trolleys, lightning arrestors, line and emergency switches, fuses, reversing switch, pole changer and motors. The third circuit, from the rails, includes, in order, rails, reversing switch, pole changer and motors. All the high-tension apparatus is enclosed in a metal case which can be opened only when the trolley bows are down.

The construction and arrangement of the trolley bows is obvious from Fig. 2 and needs little comment. Outside the tunnel the overhead lines are 17 ft. above the track. Inside, this clearance is reduced to 15 ft. 9 ins. The trolleys are operated by compressed-air pistons. Two small three-phase motors drive two small air compressors, furnishing the compressed air for the various operations about the locomotive.

NEW LOCOMOTIVES.—The two locomotives of more recent design differ from the older ones in several mechanical and electrical features. In general appearance the new ones resemble the old, particularly as regards the shape of the body and the trolley bows. From Fig. 3, however, it will be seen at once that all wheels are drivers, the number of which is raised from six to eight. The wheels are inside the journals and the cranks are mounted on axle extensions outside the bearings. The drivers are in two groups, situated well out toward the ends of the truck. This leaves space in the center of the truck for the two motors. The motor cranks are rigidly connected by an X-shaped coupling bar to whose ends are connected driving bars running to the driving-axle cranks.

The body has two doors, on each side near the ends, instead of the single door in the center of each side of the old locomotive.

The motors on the new locomotive are each of 650-HP., normal, high-speed capacity. The rotor is a simple "squirrel-cage" armature with no outside resistance circuits and no collector rings. The old method of pole changing to obtain several running speeds has been retained in general but changed to produce 8 and 16 poles or 12 and 24, which give respectively 15.5, 34.1, 21.7 and 43.4 mi. per hr. of the locomotive.

These speeds are obtained with the normal line voltage of 3,000. The lower starting voltages are obtained from transformers located in the end of the locomotive body. The various voltage-taps are brought out to duplicate drum and

*The construction of the Simplon tunnel was described in detail in Engineering News, Aug. 13 and 20, 1903. There was a short description of the type of overhead-line construction adopted and of a few features of the first locomotives in the issue of Nov. 29, 1906.—Ed.]

†The Valtellina locomotives were described in Engineering News, May 4, 1905.—Ed.]

finger contacts, on each side of the transformer shell. The two drums are geared together by a chain and one is driven by a pneumatic motor.

The disposition of the apparatus in the cab of the new locomotives is considered much better than with the old ones. Owing to the absence of side doors all the side spaces have been utilized for high-tension compartments. The central part of the cab is left free, so that easy access to the motors is made possible by trap doors. At each end of the cab is a bench for the controller. This

FIG. 2. FIRST TYPE OF THREE-PHASE LOCOMOTIVE FOR SIMPLON TUNNEL LINE.

latter, in the new locomotive, is but a collection of pneumatic valves to control the operation of the several pneumatic drums operating the motor reverser, pole changer and transformer voltage taps. The resistance control hand-wheel, of course, has disappeared. Above the controller bench are the ammeters, voltmeters, pressure gages, speed indicators, etc. The high-tension compartments are not accessible while the trolley bow is on the wire. The locomotive is lighted by direct-current furnished by a small motor-generator set.

The new locomotives were placed in service last spring, and since then have covered some 30,000 miles each. They are required to take trains of up to 20 cars normally, although they have carried 24 at times—a maximum of 500 to 550 tons. Such heavy loads have been taken up a 0.2% grade against the heavy ventilating current. With the present train service 24 trains per day are hauled between Brigue and Iselle. On Sundays there are no freight trains and all the service is carried by two locomotives. On week days three locomotives are in continual service, with the fourth in reserve. The total locomotive mileage through the tunnel and yards (approximately 13.5 miles) thus advances to about 113,000.

POWER SUPPLY.—For supplying current to the traction, lighting and signal circuits of the Simplon line there are three power stations, two at Brieg and one at Iselle. One of the Brieg plants is entirely for the lighting and signal circuits. Both these plants are driven by two 500-HP. turbines, on one shaft, which take water from the Rhone at about 146 ft. head. These turbines were used for driving air compressors during the tunnel construction and are still in the old compressor building. Adjoining the old building is a room, housing a single 1,200-HP. alternator, mounted directly on the end of the turbine shaft which is brought through the partition wall. The exciter for the alternator is belted to the turbine shaft in the old compressor house. On the other side of the old compressor building is another room which houses two 150-HP., 4,000-volt lighting generators. A small motor-generator set furnishes direct current at 110 volts for charging a storage battery at the middle point of the tunnel. These batteries in turn furnish current for the block signals, signal bells and telephone circuits.

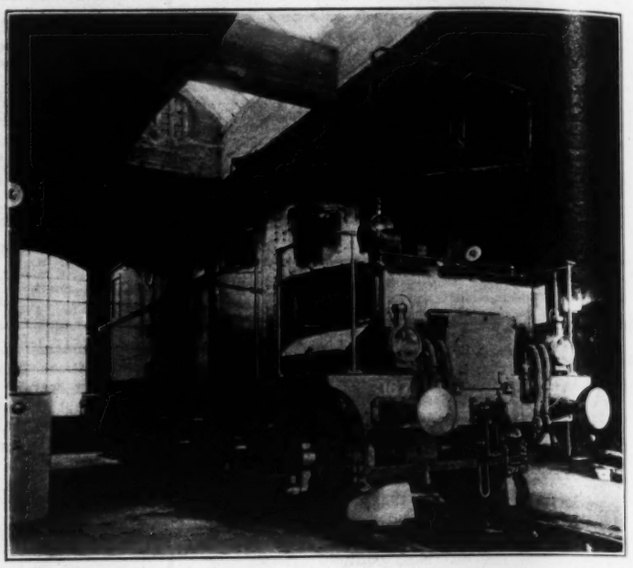


FIG. 3. SECOND TYPE OF THREE-PHASE LOCOMOTIVE FOR SIMPLON TUNNEL LINE.

At Iselle the plant, for supplying the yards and the Italian half of the tunnel line, contains a 1,500-HP., turbine-alternator unit which takes water from the Diveria at about 460 ft. head.

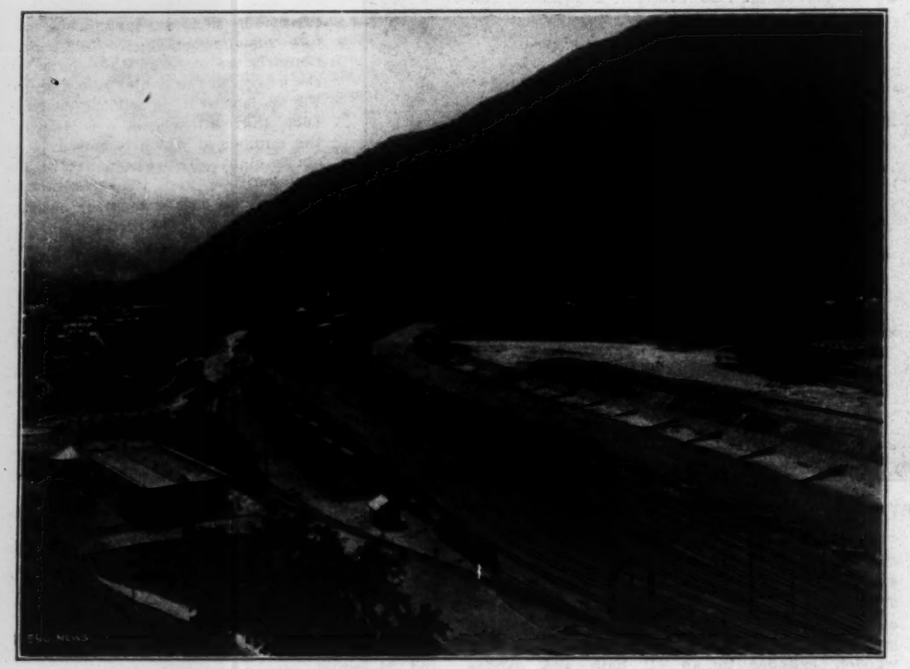


FIG. 4. YARDS OF THE SWISS FEDERAL RAILWAYS AT BRIEG.

TYPHOID FEVER ORIGINS at Strassburg, Germany, for over 3½ years, during the period from 1903 to 1907, have been studied in much detail. The studies are recorded at length in "Münchener Medizinische Wochenschrift" for June 1 and 8, 1909, and are thus summarized in the New York "Medical Record" for July 17, 1909:

Ninety-three per cent. were true typhoid and 6% paratyphoid. In all there were 505 cases. Sixty-six, or 13%, were imported cases. Milk drinking accounted for 26.7% of the cases. Only 14.6% could be traced to contaminated water, and these were frequently from bathing and swimming. Food infection accounted for 2% and direct contact for 11.9%. These latter were usually from a typical undiagnosed case. Occupation explained 4.9%. This class comprised nurses and washwomen especially. The bacillus "carriers" played an important role, as 9.5% were traced to this cause. Improper toilet arrangements accounted for 2% only. Typhoid was found to occur especially in certain streets which the author called "typhoid streets." These he explains by the residence of "carriers" on these streets. The morbidity varied with the temperature, being lowest in February and highest in August. This the author believes is due largely to the increased thirst in summer and consequent increased liability to infection. Twenty-eight definite bacillus "carriers" were discovered. The Gruber-Widal test was of help in finding "carriers," as three-fourths of these gave positive reactions.

LARGE-SCALE EXPERIMENTS ON THE UNDERflow or sub-surface flow of water through saturated sand or gravel, are being made by the U. S. Reclamation Service in the Arkansas Valley, Western Kansas. After a search and tests to locate a supposedly heavy underflow a row of wells was sunk across a valley near Deerfield, Kan., and pumps were installed there. A press bulletin issued by the Service states that the wells and pumps lowered the water plane 19 or 20 ft. below the river level; also that:

During the latter part of 1908 the wells began to weaken very materially, the total amount of water removed being 10,000 acre ft.; that is to say, enough to cover 1,000 acres 10 ft. in depth, or sufficient to irrigate, say 4,000 acres.

By April, 1909, the gravels had become filled again on the north side of the river, but in the valley on the south side the "underflow" was not sufficient to restore the amount pumped during the preceding year. During 1909 the pumps lowered the underflow much more rapidly than in 1908. Part of the wells, or groups of wells, are allowed to stand idle in order to recuperate while the others are being pumped. It is hoped that by this system of rotation as much water can be obtained in 1909 as in 1908. The experience, however, shows that the so-called underflow, even where best developed, is not a very reliable source of supply on a large scale.

The Excavating and Dredging Outfit on the Oneida River Section, Contract No. 12, of the New York State Barge Canal.*

From the western end of Oneida Lake, following in the main its outlet, the Oneida River, to its confluence with the Seneca River, at Three River Point and thence westwardly up the channel of the latter stream to Mosquito Point, one contract alone—No. 12—covers nearly 41 miles of the route of the New York State Barge Canal—the longest contract yet awarded on the line of its construction. In carrying out the provisions of this contract, an immense amount of excavation—in all more than seven million cubic yards—will be required. This is the largest excavation contract yet in force on the Barge Canal. A large proportion of this excavation lies in the channel indicated. Obviously this is best handled by the use of some form of dredging machine. And this material is so variant in its character and in the comparative ease or difficulty with which it may be removed, that no single type of dredge can be employed to best advantage in all localities. In making up the engineer's estimates, this fact was recognized to the extent of using four different unit prices in the computations, according to the nature of the spoil to be removed in each locality. In this respect, with possibly one exception, this contract stands unique. The Stewart-Kerbaugh-Shanley Co. was the successful bidder, and the award was made in August of 1907, at the contract price of $3,391,716.

As a result of a study of conditions it was thought that economy could be best secured by constructing for each of the different classes of material and conditions the machine best adapted to such conditions and material rather than employ, as a makeshift, machinery and appliances which were originally intended for different purposes.

Steam-shovels and side-dumping cars were to be used for rock or dry earth excavation. For breaking up the rock, both standard rock drills and well drills, mounted either on land or on floating drill-boats, were designed to be used as occasion demanded.

Scraper buckets were to be employed in building dikes, or levees, or for dry earth excavation in sections of the prism where conditions were favorable.

For the excavation of submerged rock it was planned to use dipper dredges and buckets of the type known as orange peel.

And for the great mass of channel excavation other than ledge rock, comprising, roughly estimated, half of the entire contract excavation, ranging all the way from the softest ooze, mud, silt, sand, muck, marls and clays of varying degrees of difficulty in removal, to cemented gravel, dredging machines of hydraulic and of ladder types seemed best adapted. As a matter of fact, all of these materials, not excepting the cemented gravel, which the hydraulic dredge was not originally intended to remove, were, on the completion and trial of these machines, handled successfully by both types of dredge.

At Brewerton, at the eastern end of the contract, the contractors have established the appliances for building, repair and maintenance of perhaps the most extensive plant of modern dredging machinery yet in use along the line of the canal—in brief, a ship-yard, where most of the squadron of great dredges, which are to bear the brunt of the conflict in the clearing of the river channels, are built, outfitted and placed in commission. Docks and ample storage yards are here provided, with offices for the engineers, the contractors and the dredge-builders.

The largest amount of rock lying within the excavation lines of this contract is situated at what is known as the State Ditch, which was constructed some years ago across Jack's Reef for the purpose of draining the Montezuma marshes. This locality has been more or less a matter of solicitude to the state authorities for just an even century, and in the efforts to secure its drainage, from first to last, an expenditure of several hundred thousand dollars has been made. The result has been a lowering of the waters in the vicinity of Cross Lake from four to five feet.

Here the line of the Barge Canal leaves the river channel and follows the ditch. The present work, however, is such a great enlargement of the latter that the ditch itself has not been of any material assistance in its prosecution. The rock excavation is to be removed in two separate cuts, the first consisting of the material which lies above the water level. The second, or last cut includes the remainder of the material between the water surface and the bottom of the prism. The first, or top cut, has now been nearly removed by means of a 70-ton steam shovel, the material being transferred to the spoil banks by 4-yd. side-dump cars running on a track of 3 ft. gage.

The second or last cut below the water level will be removed by a 2½-yd. dipper dredge. The rock is drilled for blasting by four well drills, the maximum depth of the holes being about 27 ft. In removing the first cut the rock was blasted as the drilling progressed and was at once removed by the shovel. In the removal of the second cut the drills went over the ground again and have now broken up the rock lying between the level of the water and bottom of the prism, for the full length. All of the broken rock has been left in place, to be removed later by the ladder dredge. The amount of shale rock to be here removed is some 636,000 cu. yds. in the first cut, the greatest depth of which was about 25 ft. The heavy section of work at this point extends over about 1½ miles.

DRILL BOAT.—In the second cut-off west of Brewerton, a considerable amount of submerged rock was found. This is being drilled and blasted from a drill-boat built by the contractors. A second one of similar construction is now under way. The hull measures 90 × 27 ft. 8 ins., draws a little over 5 ft. of water and carries a house 9 ft. 10 ins. wide by 70 ft. long, in which the machinery of the boat is placed. Between this house and one side of the boat are four steam-driven rock drills, mounted in guides at the side of the boat. These guides are attached to a framework of structural steel, rising about 27 ft. above the deck, and braced by struts. These four frames, each carrying a drill, may be moved on the track along the entire length of the boat. This arrangement permits a line of holes extending nearly 90 ft. to be drilled as near together as desired, the boat meanwhile being held in position by its spuds. The drills are raised or lowered in the guides by the use of block and tackle; the cylinder permits a travel of 11 ft. 5 ins., and the steel drill-bars, sharpened to 3½ ins., are in 17 and 20-ft. lengths. To provide lateral movement, when in operation, the frame is firmly clamped both to the track on the deck and to a third rail on the side of the deck-house. A small storm-house on the drill-frame protects the operators and a platform, which projects in front, permits inspection or adjustment. For work by night electric lights are provided. Within the deck-house are installed a marine boiler of 150 HP. supplying steam for the drills, and a duplex pump, supplying pressure to clean out the drill holes before charging. A double 15-HP. engine is also provided on each end of the boat to aid in forcing down the spuds, it being found that the weight of the spuds alone was insufficient for this purpose. The hull of the boat was built with double thick bottom, specially arranged to minimize the damage which might be caused by blasting. For the removal of broken rock, either a dipper dredge or an orange-peel bucket and derrick operated from a scow will be used.

HYDRAULIC DREDGE "GEYSER."—For removal of the softer materials from the channel a modern hydraulic dredge, called the "Geyser," was constructed. This was in successful operation during the latter part of the season. The hull of the "Geyser" is 96 ft. in length and of 29 ft. beam and draws 9 ft. of water. It is so constructed that it will excavate material which lies 19 ft. below the water surface and discharge its spoil at a distance of 1,500 ft. through the pontoon pipes to a shore elevation of 25 ft. above water. The steel frame projecting over the bow, supports the suction pipe and cutter-head, the driving shaft and the gearing. It is 33 ft. long and is pivoted at the inner end on one side of the elbow of the suction pipe and on the other side by a hollow pivot through which the cutter shaft is driven by a countershaft geared to a double 10 by 12 engine of 65 HP.

In the inboard suction pipe is a sluice provided with heavy bars to prevent large boulders from passing through to clog or break the pump. This is a 20-in. centrifugal, directly connected to a triple-expansion marine engine of 450 nominal horse-power, which will readily develop 550 HP. on overload. This is placed about in the center of the hull, tranversely to its length. The discharge pipe passes back on the port side to the stern of the boat, where a valve is placed to prevent the backing up of the material passed by the pump. From here it passes to the pontoon line.

The boiler plant of the "Geyser" consists of a pair of boilers of about 230 HP. each, intended for use at 160 lbs. pressure. The duplex pump furnishes water under pressure to the pump stuffing-box gland and to the cutter-head bearing. Two other duplex pumps are used to feed the boilers either directly or through a 400-HP. feeder. These pumps take suction either from cold water or the hot well, as desired, as do the injectors, of which there is one provided for each boiler. All the pumps can be used also for fire purposes.

A 6-KW. generator supplies electric current for the lights used in operating by night. The hoisting winch has five drums and is operated by a double engine of 45 HP. Upon the forward shaft, the drums on each side swing the dredge and the center drum raises and lowers the suction ladder. The two after drums are used for operating the spuds. A winch-head is placed on either side of the deck for mooring purposes, etc. The pilot house is placed directly over the winch and from this, by means of levers the operator has complete control of the hoisting and lowering of the ladder and the spuds, the swinging of the dredge or the speed of the cutter engine.

The line of pontoon boats which supports the 20-in. discharge pipe is built and floated upon heavy water-tight casks, placed underneath. The steel discharge pipe is in 32-ft. sections on the pontoons and half that length for the shore sections. Connections between the pontoon pipe sections are by means of heavy rubber sleeves fitting over the ball-shaped ends of the pipe. The shore lengths are adjusted by simply telescoping, no sleeves being needed. At the shore a terminal pontoon is used for the purpose of raising the end of the pontoon line to connect with the shore line. This is done by a block and tackle and an A-frame, which supports one end of the pipe. For the pontoon line about 600 ft. of pipe are provided, and for the shore line, 800 ft.

This dredge, when built, was intended for use only in the softer material, but early in its operation it encountered a quantity of cemented gravel, a material not originally intended to be removed by this type of dredge. To expedite matters, the dredge was driven through this gravel with no adverse results beyond a decrease in the output and a more rapid wearing of the cutter. This, however, was remedied by the substitution of a much stronger cutter, weighing some 7,000 lbs., which answered the purpose. This cutter is 5½ ft. in diameter by about 4 ft. long. Its speed is about 18 revolutions per minute. The "Geyser" was placed in commission on July 7, 1908, and until laid up for the winter about Dec. 1, it was in constant operation, working three 8-hour shifts per day, with but little loss of time for repairs.

FIG. 5. OVERHEAD CONSTRUCTION FOR 3,000 VOLTS. YARDS OF SIMPLON TUNNEL LINE AT BRIEG.

*Extract from an article in the "Barge Canal Bulletin," March, 1909.

On the spoil areas, to retain in place the silted portion of the output of this dredge and permit its settling, dikes or levees are required, both in front and rear. The front levee is built of material taken from the prism and charged as excavation, the rear levee, however, being built of borrowed material at the contractor's expense.

TWO LADDER-DREDGES.—In the cut-off west of Brewerton there is a heavy overburden of swamp land—loam and mud—amounting to nearly a quarter of a million yards. A 70-ton steam shovel was used in its removal, and the first or upper cut was started at water level. It was found, however, that the clay beneath this loam and muck would not support the weight of the shovel. A change was therefore made by raising the bottom level of this cut about 4 ft., and even with this some difficulties have been met. The spoil is removed by locomotives and dump cars. The second cut below the last-named level is to be removed by the larger dredges.

The two heavy ladder-dredges, called the "Cyclone" and the "Tornado," have been built for this contract during the past season, and are of twin construction as to the dredges themselves. The combination of bucket-dredge, or elevator, and of belt-conveyor is novel so far on the line of the canal, although this combination has been much used in placer-mining on the Pacific coast and by the Federal government on the Fox River, Wis.

The conveyor systems are practically interchangeable, each being built on separate floating structures which follow the dredge as the tender follows a locomotive. One of these systems is intended to be used in wide waterways and passes its material into scows placed either astern or preferably along the side. The scows, when loaded, are towed out in pairs to deep water in the lake and dumped. In this system the attending conveyor is called the delivery scow. In the other system it is known as the intermediate conveyor, and to this is attached a third section, called the shore conveyor. So far, the dredge "Cyclone" has been using the scow conveyor system, while its companion, the "Tornado," was equipped with the shore conveyor.

The dredge hulls were so constructed as to pass the locks of the present Erie Canal. To do this it was necessary to build them in parts, as separate pontoons, which, when in use, are brought together side by side and strongly braced. When separated, each pontoon passes the canal locks carrying its own complement of machinery. The largest sectional pontoon is 96 ft. in length by 17 ft. in width and draws 9 ft. of water. The hulls themselves are of heavy plank and timber construction, and when in place, are held together by steel truss frames in such manner as to be readily disconnected when desired. In outline the hulls are flat-bottomed and the bows blunt-pointed, while the sterns are square. All gantrys and top frames are of structural steel and are constructed so as to be lowered while passing locks or bridges. They are connected by pin bolts and turnbuckles for the purpose of enabling them to draw up to place.

The dredge is swung to and fro across the cut by wire ropes extending from two winch drums and anchored to trees or deadmen on opposite sides of the canal. In this way the elevator buckets, as they pass forward, are forced sidewise into the cut, the entire dredge swinging in the arc of a circle around a center located just behind the stern. This center is the pivot by which the dredge is attached to the cross frame, carrying at each end a steel spud of ordinary construction. The spuds are raised and lowered by engines and gearing applied directly to the spud frame. When digging, both spuds are down, holding the dredge from slipping back. To move ahead, one spud is elevated. The spud frame is then swung part way around by the wire rope connected to the winch and the first spud is lowered again in its new position. The operation is then repeated with the other spud, each time the swinging of the spud frame, with one spud on the bottom, acting as a pivot to move the dredge ahead. The second operation brings the spud forward again straight across the channel. For handling the heavy spuds, a special 8 × 8½-in. reversible engine about 40 HP. is provided, to which each of the spuds is connected, as above stated.

The heavy ladder-frame which carries the bucket-line is built of structural steel and is 50 ft. in length. The upper end is hinged to what is called the upper tumbler-shaft. The lower end is suspended by means of heavy tackle, which is in turn supported by the main or bow gantry. This gantry is of steel construction, securely braced and well adapted to support the digging ladder.

It may here be noted as of interest, that in this class of dredge the bucket line may be arranged in either of two ways, as the character of the material requires. For the softer materials the buckets are joined directly, following each other closely on the chain. For harder excavation each alternate bucket in the line is replaced by a link connection, making an open line of buckets, better adapted for working in the hard material. In the dredges under discussion the buckets are arranged closely, as first described.

Each bucket weighs a ton, or to be exact, 2,050 lbs., and has a capacity of 8½ cu. ft. when full. They are built in three parts, the bottom being made of specially treated, open-hearth, basic steel castings, the head of pressed steel and the lips, or cutting blades, of manganese steel. In construction they are similar to those built by the company for use in the large placer-mining dredges of the West. They are held together by 4-in. steel pins. The bucket-line is driven with a 10 × 14-in. double cylinder, horizontal engine of 100 HP., while another 8 × 8-in. engine of the same type, of 40 HP., raises or lowers the ladder.

A monitor is provided for each dredge, through which water passes at high pressure, when required, for the purpose of breaking away or washing down the material from high banks in front of the dredge to a position where it may be reached by the buckets. A 12-in. centrifugal pump, directly connected to an 11 × 10-in. marine engine, furnishes water for this monitor.

The power used to operate the dredge is, in the broad sense, steam, yet the conveyors and main winch are driven by electric motors, the electric power for this being obtained from a 100-KW. generator, directly connected to a 13 × 16-in. horizontal, single-cylinder engine. As the work progresses the buckets are fed into the bank by swinging the dredge hull by means of the cables attached to the shore. On board, these cables are handled by a 5-drum winch, driven by a 25-HP. electric motor.

As the material passes from the bucket line at the top, it is delivered into a large chute, or hopper, across the bottom of which is a grating of heavy grizzly bars whose purpose is to separate the large stones, too heavy to be safely carried on the belt-conveyor, from the rest of the material, which passes between these bars and out upon the conveyor-belt. This belt-conveyor is fitted with idlers, etc., and is 4 ft. wide, made double thick, of canvas and rubber and conveys the material 60 ft. to the rear of the dredge. The belt is driven by a 25-HP. electric motor.

From here the material passes to the delivery scow, on which is another belt-conveyor, 42 ins. wide and extending the entire length of the delivery scow and which rises to the proper elevation for delivery from the rear end, or dumps through a tipping chute—pivoted to dump either way by tipping—into the scows. The inclination of this belt may thus be raised to a maximum of 11° with the horizon. The delivery scow is also equipped with a winch for placing the dump scows, raising the spud at the stern and tipping the delivery chute. This is driven by another 25-HP. electric motor. These three motors, which have been described, receive their power from a 100-KW. generator on the dredge, directly connected to a 13 × 16-in. horizontal, single-cylinder engine.

The dredge is also equipped with a 12-in., combined, centrifugal pump, driven by a 100-HP. double engine. This pump supplies water for the hoppers and, by means of a perforated pipe leading along underneath each side of the belt, supplies jets of water for the purpose of keeping the belt-conveyor clean. On the dredge are also installed two other steam pumps, of locomotive type, of about 150 HP. each. This makes about 500 HP. on board, although not all of this is in use at once.

We have said that the dredges are of twin construction, but in the shore conveyor system, with which the "Tornado" is equipped, the delivery scow is disconnected and replaced by an intermediate scow, to which is added the shore conveyor, 200 ft. in length. On the intermediate scow is a 42-in. belt-conveyor, 60 ft. long. This delivers to the shore conveyor, which is also supported on a scow, 80 ft. long by 52 ft. wide and built in sections, to pass the canal locks. This places the material 100 ft. inshore and at any desired height up to 60 ft. above water. In addition to building the beam 60 ft. high, the shore conveyor is equipped with a chute to wash the material still further back some 30 ft. The intermediate conveyor is driven by a 20-HP. motor, and the short section by a 70-HP. motor.

All of the dredge machinery, as well as these conveyors, are controlled by one operator, standing in a small house located on the dredge in such a position that he has a full view of all the work, from the cut in front to the scows in the rear. If working at night, electric lights are provided, which are so placed as to throw light on the work but leave the operator in darkness. The men required are the operator, an engineer, a fireman, an oiler and a deck hand on the main dredge, also a man for handling and controlling the conveyor-belts and three men for handling the scows while loading. The shore scow has one man and the intermediate scow has one. A tug and from four to six dump-scows are in attendance on the "Cyclone." The scows are bottom-dumping, standard type, 250-cu.-yds. capacity, 80 ft. wide, and are built in five compartments. The theoretical speed of the bucket is 22 per minute,—loading a scow in 36 minutes. This output is reached only in favorable material. The dredge has proved its ability to operate in sand, soft mud, quicksand, boulders, hardpan and even rock, if blasted ahead. The largest fragment so far observed in the buckets was a 24-in. stone. The larger boulders can be removed by electric cranes or hoists from the buckets, even before reaching the grizzly bars. Some changes have been contemplated, especially for handling large boulders—say up to 30 ins., without stopping the buckets. These and other changes will doubtless be made before the beginning of next season.

In the delivery of material to the scow beyond the dredge the operator can control the speed of the belt. When large fragments are being passed, the speed is reduced, not to damage the belts, chutes, etc. When the output is soft material, with considerable admixture of water, the speed is increased, thus carrying mud, water and all to the top of the belt. For this purpose the speed may be changed from 250 ft. to 500 ft. per minute.

No claim should be made that the ladder-dredge will exceed the hydraulic type in quantity of output, but it should be remembered that it handles harder material than the latter. Under the plan contemplated the hydraulic dredge is in advance and removes the softer material, which it is best fitted to handle, and the ladder-dredges follow, taking "anything a man can pick."

The Barge Canal Bulletin desires to acknowledge the many courtesies received from the officials and employees of the contractors and the Bucyrus Co. of South Milwaukee, Wis., which built the dredges, and to express its thanks for information given in the preparation of this article, especially to the veteran dredge-builder, Capt. Rush. C. Beard.

Cast-Iron Wheel Specifications.

The following specifications for 33-in. cast-iron car wheels were adopted at the 1909 convention of the Master Car Builders' Association and passed to letter ballot for final approval:

SPECIFICATIONS FOR 33-IN. CAST-IRON WHEELS FOR CARS OF 60,000, 80,000 AND 100,000 LBS. CAPACITY.

1. Chills must have an inside profile that, in the finished wheel, will produce the exact form of flange and tread contour shown by M. C. B. drawings adopted in 1909. The normal diameter of the wheel produced by the chill must be the M. C. B. Standard of 33 ins., measured at a point 2⅝ ins. from outside of tread of wheel.

2. Wheels furnished under this specification must not vary more than ¼ in. above or below the normal size "measured on the circumference," and the same wheel must not vary more than 1/16 in. in diameter. The body of the wheel must be smooth and free from slag, shrinkage or blowhole. The tread must be free from deep and irregular wrinkles, slag, chill cracks and sweat or beads in throat, and swelled rims.

3. The wheels must show clean gray iron in the plates, except at chaplets, where mottling to not more than ½-in. from same will be permitted. The depth of pure white iron must not exceed 1 in. nor be less than ¼ in. in the middle of the tread.

(A) It shall not exceed 1 in. in the middle of the tread nor be less than ⅜ in. in the throat, for wheels having a maximum weight of 625 lbs.

(B) It shall not exceed 1 in. in the middle of the tread nor be less than 7/16 in. in the throat for wheels having a maximum weight of 675 lbs.

(C) It shall not exceed 1 in. in the tread nor be less than ½ in. in the throat for wheels having a maximum weight of 725 lbs.

(D) The depth of white iron shall not vary more than ¼ in. around the tread on the rail line in the same wheel.

4. When ready for inspection, the wheels must be arranged in groups, all wheels of the same date being grouped together, and for each hundred wheels which pass inspection and are ready for shipment, two representative wheels shall be taken at random, one of which shall be subjected to the following tests:

The wheels shall be placed flange downward on an anvil block, weighing not less than 1,700 lbs., set on rubble masonry at least 2 ft. deep, and having three supports not more than 5 ins. wide to rest upon. It shall be struck centrally on the hub, by a weight of 200 lbs.

(A) For wheels having a maximum weight of 625 lbs. 10 blows falling from a height of 9 ft.

(B) For wheels having a maximum weight of 675 lbs., 12 blows falling from a height of 10 ft.

(C) For wheels having a maximum weight of 725 lbs., 12 blows falling from a height of 12 ft.

Should the test wheel stand the given number of blows without breaking in two or more pieces, the Inspector will then subject the other wheel to the following test:

The wheel must be laid flange down in the sand, and a channel way 1¼ ins. wide and 4 ins. deep must be molded with green sand around the wheel. The clean tread of the wheel must form one side of the channel way, and the clean flange must form as much of the bottom as its width will cover. The channel way must then be filled to the top with molten cast iron, which must be hot enough when poured, so that the ring which is formed, when metal is cold, shall be solid or free from wrinkles or layers. The time when the pouring ceases must be noted, and two minutes later an examination of the wheel must be made. If the wheel is found broken in pieces, or if any crack in the plate extends through or into the tread, the 100 wheels represented by the tests will be rejected.

5. In the drop tests, should the test wheel break in two or more pieces with less than the required number of blows, then the second wheel shall be taken from the same lot and similarly tested. If the second wheel stands the test it shall be optional with the inspector whether he shall test the third wheel or not; if he does not do so, or if he does, and the third wheel stands the test, the hundred wheels shall be accepted as filling the requirements of the drop test.

6. The lower face of the weight of 200 lbs. shall be 8 ins. diameter, and have a flat face.

7. The thickness of the flange shall be regulated by the maximum and minimum flange thickness gages adopted by the M. C. B. Association in 1907.

All wheels furnished under this specification must conform to the respective sections shown by M. C. B. drawings for the different weights of wheels, and these weights shall be as follows:

(A) Wheels for service under 60,000 lbs. capacity cars shall have a maximum weight not exceeding 625 lbs., and a minimum weight not less than 615 lbs.
(B) Wheels for service under 80,000 lbs. capacity cars shall have a maximum weight not exceeding 675 lbs., and a minimum weight not less than 665 lbs.
(C) Wheels for service under 100,000 lbs. capacity cars shall have a maximum weight not exceeding 725 lbs., and a minimum weight not less than 715 lbs.
(D) Weights given for the respective wheels mentioned in sections A, B and C are based on M. C. B. Standard drawings covering wheel design adopted in 1909.

8. All wheels must be numbered consecutively in accordance with instructions from the railroad company purchasing them and must have the initials of such railroad company, also the wheel number, the weight of wheel, and the day, month and year when made plainly formed on the inside plate in casting. No two wheels shall have the same number. All wheels shall also have the name of the maker and place of manufacture plainly formed on the outside plate in casting.

Wheels conforming to the requirements, and furnished under this specification must have the letters "M. C. B., 1909," plainly formed on the outside plate in casting.

9. Individual wheels will not be accepted which
(1) Do not conform to standard design and measurements.
(2) Are under minimum weight. All excess weight over the maximum given to be at the expense of the manufacturer.
(3) Have physical defects described in Section 2.

Any lot of 100 wheels submitted to test will not be accepted
(1) If wheels broken do not meet the prescribed drop test.
(2) If the wheel tested does not stand the thermal tests.
(3) If the conditions prescribed in Section 3 are not complied with.

10. All wheels must be taped with M. C. B. Standard design of wheel circumference tape having numbers 1, 2, 3, 4, 5 stamped ⅛ in. apart, the figure "3" to represent the normal diameter, 103.67 ins. circumference. The figure "1" the smallest diameter and the figure "5" the largest diameter.

A New Method of Drying Peat.*

By M. EKENBERG, Ph. D.

With the present methods of manufacture of iron and steel, charcoal is still, by reason of its low percentage of sulphur and phosphorus, an almost indispensable fuel in the manufacture of the finest qualities of iron. The production of charcoal in general has decreased, and is only flourishing in remote countries where the value of forests is low. At the same time the demand for charcoal has increased with the development of the iron industry.

As peat is of a woody nature, consisting practically of a more or less oxidized cellulose with comparatively little sulphur and phosphorus, there is every prospect of its being a suitable raw material for charcoal. Peat-bogs are distributed all over the surface of the earth, and it has been estimated that there is more carbon in the peat deposits than in all known coal-fields. Yet the carbon in peat-bogs is not ready to be "mined." Even if well drained, a peat-bog contains on an average about 87½% water, and only about 12½% of peat substance.

No method of drainage has been found whereby a lower percentage of water can be obtained. If artificial heat is to be applied for evaporating this water more fuel would have to be consumed than furnished by the dry peat substance that would be obtained. The idea of using artificial heat to evaporate the main part of the water is therefore absolutely excluded from practical consideration.

The only method which has hitherto yielded practical results is drying it by the sun's heat during the summer months. When working peat this "air-drying" is more or less the chief operation in eliminating the bulk of the water, but it is obvious that successful working is dependent upon atmospheric conditions. Experience has shown that it is extremely difficult to get a regular supply of air-dried peat, and no industry can depend upon peat-fuel to any extent for this reason.

The mechanical pressing out of the water from peat has frequently been suggested, and experiments on a small scale with surface peat have given positive results; but the black fuel-peat, which predominates in peat deposits, does not give off its water when submitted to pressure. It has been declared a technical impossibility to press out the water mechanically from mature peat, i. e., black fuel-peat.

The author has found that the reason that the water does not separate under pressure is because of the presence of a slimy hydrocellulose, produced from the residues of the decaying plants of which mature peat consists. This hydrocellulose is formed by prolonged contact of the cellulose with water. It is present to the extent of 0.2 to 1.2%, and more, of the peat substance, and can be extracted from the peat. It readily forms dextrose, and is destroyed by heating in the presence of water to temperatures above 150° C. He has examined numerous peat samples from different parts of the world and found that they all contain this hydrocellulose. The greater the percentage present the more difficult it becomes to separate the water. The isolated hydrocellulose has remarkable properties. In peat it is enormously swollen, having taken up water and formed a jelly of the consistency of soft soap. A jelly containing twenty-five times its own weight of water is still comparatively stiff, and can be cut into slices. If the jelly be pressed in a canvas bag, it passes unchanged through the meshes without separating water. Submitted to pressure, it transmits the pressure in all directions like a homogeneous solution. A pulp from mature peat submitted to pressure also passes unchanged through the meshes of ordinary canvas with holes of about 1 sq. mm. If, however, the hydrocellulose present in the raw peat-pulp is extracted or destroyed, the bulk of the water can easily be separated from the plant residues by pressing the peat in a canvas bag, or against a suitable metallic grating. If such pressable peat be mixed with a small percentage of slimy hydrocellulose and water to the amount of that contained in raw peat, it again becomes impossible to separate the water by mechanical pressure, the pulp going right through the meshes.

It is this hydrocellulose which binds the particles together in the peat-sods obtained when making air-dried peat in the usual way. Under the microscope the hydrocellulose can be seen as a jelly, on staining the preparation with fuchsine or methylene blue. The accompanying figures show the structures at magnifications of 300 diameters. A typical mature fuel-peat appears as a mixture of a few fibers embedded in a preponderant mass of broken-up plants in a more or less decayed state. The cells are filled with, and surrounded by, a gelatinous or slimy substance, which is the hydrocellulose. The surface peat, however, appears as fibers of various kinds with large cells. But little, if any, slimy hydrocellulose is found in surface peat.

When it had been ascertained that a substance of the nature of hydrocellulose prevented the water from being pressed out of peat, there was comparatively little difficulty in devising a treatment by which the separation of water could be effected, the hydrocellulose having been found, as previously stated, to be destroyed by heating. By increasing the temperature of heating other changes also take place. Thus, the percentage of carbon in the peat gradually increases with the rise in temperature, and a portion of the components—hydrogen and oxygen—combine to form water. The difference between this carbonizing process and the ordinary dry-charring in retorts is the presence of fluid water. The heat is transmitted to the water which surrounds every peat particle. Water is a much better conductor of heat than gas, allowing a sharply defined charring with a uniform effect, corresponding exactly to the temperature used. The heating has, of course, to be done in closed vessels to prevent evaporation.

As the heating medium is superheated liquid water, and as the percentage of carbon increases, the author believes himself justified in describing such treatment as "wet-carbonizing."

In the dry process large volumes of gases are evolved, together with tar, while acids and water distil over. Practically no gases are to be observed in the wet process. The tar remains in the peat, and only traces of acids are formed. Organic compounds of higher molecular weight and of a non-corrosive nature are found in the pressed-out water to the extent of 0.10 to 0.60%.

When manufacturing fuel from peat, the decrease in weight through the formation of water during wet-carbonization is not to be regarded as an actual loss. It only means concentration, and the value of the product increases in proportion. The increase in the calorific value of the peat is seen in Table I.

The calorific value seems to depend chiefly upon the temperature used. Young (of comparatively recent formation) and mature peat alike yield a product of about the same calorific value at a certain temperature, which is a point of great practical importance, as it secures a uniform product from the different layers of peat in a bog. The only difference between young peat and mature peat seems to be that the young peat forms more water, thus giving a lower net yield of product than mature peat. As the calorific value increases there is a rise in the percentage of carbon, as shown in Table II.

The press-cakes of peat show a slightly higher percentage of nitrogen than the raw peat used, which is the result of the general concentration which the peat undergoes.

*From a paper presented at the annual meeting of the Iron and Steel Institute, London, Eng., May 13.

TABLE I.—THE EFFECT OF HEATING WET PEAT ON ITS CALORIFIC VALUE.

		Calories per Kg.	B.T.U. per lb.
Peat "S,"	water free, raw	5,571	10,000
" "	wet-carbonized at 170° C.	5,880	10,600
" "	wet-carbonized at 225° C.	6,480	11,600
" "	wet-carbonized at 320° C.	6,800	12,200
Peat "T,"	water free, raw	4,950	8,920
" "	wet-carbonized at 200° C.	6,250	11,200
Peat "L,"	water free, raw	5,150	9,280
" "	wet-carbonized at 100° C.	5,210	9,380
" "	wet-carbonized at 180° C.	5,830	10,500
" "	wet-carbonized at 200° C.	5,980	10,800
" "	wet-carbonized at 230° C.	6,200	11,200
Peat "W,"	(young peat), water free, raw	4,550	8,220
" "	wet-carbonized at 200° C.	6,080	10,900
Peat "D,"	(young peat), water free, raw	4,740	8,530
" "	wet-carbonized at 200° C.	6,120	11,000

TABLE II.—THE EFFECT OF TEMPERATURE ON COMPOSITION OF PEAT.

Peat.	Wet-Carbonized at— 180° C.	200° C.	220° C.
Carbon	61.9%	63.8%	65.9%
Hydrogen	6.8	6.3	5.8
Nitrogen	1.2	1.1	1.1
Oxygen	27.1	25.7	24.0
Ash	3.0	3.1	3.2

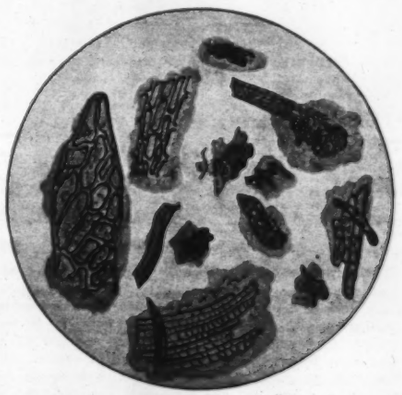


Fig. 1. Mature-Peat Pulp, as It Appears Under the Microscope.
(The cells are filled with and surrounded by a slimy hydrocellulose.)

Fig. 2. Mature-Peat Pulp After Heating to 200° C.
(The slimy cellulose of the raw peat has disappeared.)

For the purpose of determining the effect of heating at different temperatures, the author selected a very soapy black peat with a high percentage of hydrocellulose. The percentage of water was adjusted exactly to 87½% by adding water. The peat was made into a homogeneous pulp, and passed through a sieve with holes of 1 sq. mm. By pressing the pulp in a fine press cloth at a pressure of 300 lbs. per sq. in. no water was separated, and the cloth burst. In a coarser cloth the pulp passed right through the meshes. The results are shown in Table III.

Wet-carbonized peat obtained at temperatures above 180° C. can easily be pressed by hand, giving off the bulk of the water, a part of the water having been already separated during the heating. Experiments in exposing the peat to various temperatures for a longer period—ten minutes or half an hour—yielded no better results. At 150° C. a sudden change takes place (see Table III.), which indicates that at this point the hydrocellulose commences to decompose. Dried above 100° C. the peat gradually gives off a little water until 140-150° C. is reached, when the weight remains the same for hours. If the peat is heated dry, the first acid distillate is observed at a temperature of about 160° C. These facts explain to some extent the changes taking place on heat-

TABLE III.—THE EFFECT OF TEMPERATURE IN PRESSING PEAT.

	Temperatures used, Degrees C.	Lbs. water per lb. peat substance remaining.	Lbs. water pressed out per lb. peat substance.
Raw peat pulp	...	Sack burst	...
Pulp heated to	80	" "	...
" " "	100	6½	½
" " "	125	6	1
" " "	150	3½	3½
" " "	160	2	5
" " "	180	1½	5½
" " "	200	1	6
" " "	220	½	6½
" " "	240	½	6½

ing the peat in the presence of water at temperatures above 150° C.

The results set out in the table seem to show that the possibility of successful pressing depends first of all upon the temperature used. The influence of pressure as a separating factor cannot, however, be ascertained from the above table. A series of observations on this point were made by pressing the peat in a hydraulic press and measuring the outflowing water at certain points, the pressure not being increased until the water ceased to flow. The results are graphically recorded in Fig. 3. For these observations a raw pulp containing 7 lbs. of water to 1 lb. of peat substance was again used, and the figures indicate how many lbs. of water separated from each lb. of peat substance at certain pressures.

The influence of the slimy hydrocellulose is clearly seen from the curves. The peat heated to 125° C. under the prevailing experimental conditions showed nearly a straight line—very different from the other curves. Further experiments were therefore carried out, using pressure up to 280 atmospheres, when a curve similar to the curve for 150° was obtained, but the bend commenced at 40 atmospheres and 2 lbs. of water, ending with 5 lbs. at 280 atmospheres. All the curves begin as straight lines. The curve for 160° C. indicates that there is still some slimy matter left in the peat at that temperature. The curves for 180° C., and higher, clearly show that for practical purposes at least 180° C. ought to be used. The bulk of the water, viz., 5 lbs. out of the 7, readily leaves the peat at the low pressure of 2 to 4 atmospheres.

A third factor of influence on the results of pressing is the time. A sudden rise in pressure, not giving the water time to separate, naturally causes very different results. Gradually increasing the pressure to 50 atmospheres for a period of half to one minute in one instance, compared with five to ten minutes in another instance, shows no difference when pressing carbonized peat. In peat with slimy matter, partly or wholly unchanged,

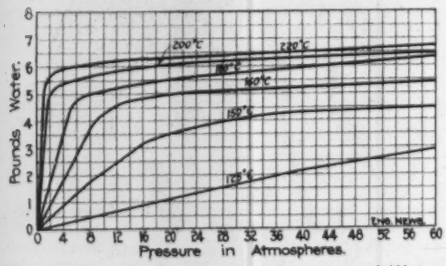


Fig. 3. The Relation Between Pressure and Water Expelled for Various Temperatures, Ekenburg Process of Peat Drying.

the water requires a long time to separate, and for such peat time was found to be a very important factor.

In view of the great bulk of water present in raw peat heating was thought to be too expensive, and therefore several other means for destroying the hydrocellulose were tried—e. g., the adding of chemicals, passing an electric current through the peat-pulp, freezing it, etc., before pressing it. None of these means, however, proved successful. The hydrocellulose is comparatively resistant to the action of chemicals, which have only the desired effect when in high concentrations. The water present in raw peat makes it necessary to use ten times as much of the chemicals than would otherwise suffice.

The effects of an alternating or continuous electric current at 50 to 1,000 volts have also been tried. When the current passed through without the temperature being allowed to rise more than a few degrees the effect was nil, even at 1,000 volts. The hydrocellulose was not noticeably changed. If the temperature was raised 60° to 80° C, some effect on the peat could be observed, especially when under pressure during exposure to the electric current. No adequate results were obtained when mature peat was treated, and the effect obtained was chiefly to be attributed to the heat developed by the electric current. As electricity is a comparatively expensive heat-producer, ordinary fuel is to be preferred.

The idea of "bursting the cells" by freezing the peat for the purpose of being able to press out the water has been frequently discussed, and thought to be specially adaptable in cold countries. The experiments made by the author showed that frozen young peat gives off its water more easily than mature peat after having been thawed and pressed within an hour, but the results were not so good as when an electric current was used.

APPLICATION OF THE NEW PROCESS.—The results obtained from the above researches and experiments show beyond doubt that by previously heating the peat to a certain temperature the bulk of the water can be mechanically expelled at low pressure. Moreover, it shows that this treatment equalizes the different kinds of peat, converting all peat, young and mature, into a product of uniform properties and fuel value. As a basis

TABLE IV. A.—HEAT BALANCE, EKENBERG PROCESS.

800 kg. (1,765 lbs.) peat-pulp containing 100 kg. (221 lbs.) peat substance at.	5,600 calories	(10,000 B. T. U.)
Heat available in the fuel	560,000 calories	(2,220,000 B. T. U.)
Deduct carbonization heat, 100 calories per kg. pulp	80,000 calories	(317,000 B. T. U.)
Leaving	480,000 calories	(1,905,000 B. T. U.)

for a commercial process, this treatment has the advantage of not requiring outside raw materials. The heat and power required can be produced by a part of the peat itself, making a manufacture independent of weather and season. The carbonization is instantaneous, and the time required for making fuel from the raw peat is only that required for heating, cooling, and pressing. The pressing can be done within a minute, and the heating and cooling ought not to require more time than the heating and cooling of water, provided an efficient apparatus is used.

Air-drying occupies one to three months. With suitable mechanical arrangements, the wet-carbonizing process ought not to take more than 30 minutes in all.

The important question remaining to be discussed is: How much heat and power respectively will the process require? To heat the peat up to, say, 200° C., no more than 200 calories per kilogram (360 B. T. U. per lb.) need be used. The specific heat of the peat-pulp is 0.92, or say, 1. As free or sensible heat can be regenerated, the net cost of the heating ought only to be a part of the 200 calories required to reach the desired carbonizing temperature. The heated pulp can be cooled by the raw pulp awaiting its turn to be heated, and thus great saving of heat obtained. The author has tried regeneration of heat on a large scale, with an apparatus consisting of one double tube built according to this principle, with a space of half an inch between the outer and inner tubes, thus securing a rapid interchange of heat. The pulp was forced through the tube with an ordinary sludge pump at a pressure a little above the tension of steam at the selected carbonizing temperature, and boiling thereby prevented.

The results are shown in table IV.

TABLE IV.—RECOVERY OF HEAT FROM PEAT PULP.

Carbonizing temperature	180° C.	200° C.	220° C.
Temperature of raw pulp entering	21° C.	19° C.	14° C.
Temperature of cooled pulp discharged	80° C.	93° C.	80° C.
Regeneration	91° C.	107° C.	140° C.
Net cost of wet-carbonization, calories per kg.	68	74	66
Net cost of wet-carbonization, B. T. U. per lb.	122	133	119

From these results it is obvious that 57 to 65% of the heat applied can be regenerated, and the higher the carbonization temperature, the better the regeneration. Compared with dry-carbonization, where it is hardly possible to regenerate any heat, this method of carbonization is vastly superior. Instead of conducting the heat through gases to the substance, fluid water is the heating medium, and the apparatus can be built upon the principles of a tubular boiler. The regeneration of heat is only a question of the cost of apparatus to secure sufficient cooling surface.

Trials on a larger scale with a system of 52 tubes, through which 50,000 gals. of peat-pulp were pumped, gave the following results:

Average temperature at the heated end of the tubes	152° C.
Temperature of raw pulp entering.	10° C.
Temperature of pulp discharged...	80° C.
Regeneration	72° C.
Net cost of carbonization	70 calories per kg. / 126 B. T. U. per lb.

It is known from experience in steam-raising that the heat developed from gaseous fuel is utilized to the extent of 70 to 80%, the balance being losses through the chimney and through radiation. If these figures are applied to the wet-carbonizer, the total cost of heating will be 90 to 100 calories per kg. wet pulp (162 to 180 B. T. U. per lb.) which corresponds with the figures actually obtained from experiments.

Calculated on the basis of mature fuel-peat of 5,600 calories per kg. (10,000 B. T. U. per lb.) the heat balance of wet-carbonization is as in Table IV. A. These 480,000 calories remaining are equal to 85.7 kg. (189 lbs.) peat substance. Consequently about 14.3% of the peat in the pulp has to be sacrificed in the wet-carbonizing oven, but against this a continuous process and a concentrated fuel are secured. In view of the low value of peat-bogs, the cost of the fuel in the process equals practically only the expense of its excavation and transport to the factory.

Assuming that one-seventh of the original water in the peat is left in the press cakes, or 1 lb. of moisture per lb. of peat, the cost of eliminating this moisture by artificial heat would be equal to the evaporation of 100 kg. water from each 100 kg. wet-carbonized peat.

100 kg. water (220 lbs.) require for evaporation 640 calories per kg. (1,150 B. T. U. per lb.) or total	64,000 calories (254,000 B. T. U.)
To cover 25% losses add.	16,000 calories (63,600 B. T. U.)
Per 100 kg. (220 lbs.) dry peat	80,000 calories (317,600 B. T. U.)

These 80,000 calories are equal to 14.3 kg. peat, of 5,600 calories, or a further 14.3% loss, but a water-free fuel is thus produced. It is possible to carry out the drying partly with the waste heat from other parts of the factory, *e. g.* the wet-carbonizing oven and power plant, thereby saving 20 to 30%.

For pressing out the water, any press capable of working at 50 atmospheres can be used. The bulk of the water is separated by the pressure in the oven, which is 15 to 20 atmospheres produced by the pulp pump, and an additional pressure is given by the ram of the briquetting press.

The cost of pressing with gasified fuel and gas-engines is equivalent to a consumption of 1½% of the peat, all transformation losses included.

To try the effect of briquetting, the author sent two carloads of wet-carbonized peat to a lignite briquetting factory in Germany, and the briquettes obtained were excellent. Power, heat, and labor for briquetting lignite are well-known items, and when all heat and power required for excavation, transport, pulping, pumping, carbonizing, pressing, final drying, and briquetting are estimated, the conclusion may be arrived at that the total fuel consumption in making briquettes from wet-carbonized peat will equal 37% of the fuel available in the raw peat.

At the author's request Mr. C. Dellwik has carefully computed the probable manufacturing expenses of the briquettes, based upon a price of about $100 per acre of peat bog, of average depth and with existing labor conditions. He arrived at the figures of Table V.

TABLE V.—COST OF DAILY PRODUCTION 100 TONS BRIQUETTES.

Value of the peat in the bog	$15.00
Wages for excavation by machinery	5.75
Wages for transport to factory	6.00
Wages in the factory	50.00
Depreciation and maintenance of plant	60.00
Administration and sundry expenses	30.00
Total	$166.75

Considering the high fuel consumption in the factory, the question of possibly recovering some by-products from the fuel used which would recoup part of the expenses has been investigated. Attention was first devoted to the nitrogen. In modern plants for producing coal gas the nitrogen is recovered in the form of sulphate of ammonia, a readily marketable article of increasing demand.

The recovery of nitrogen from that part of the peat which has to be used as fuel in the manufacture of wet-carbonized peat is to be looked upon as a sound proposal. It considerably increases the percentage of fuel required, viz. from 37% to about 45%, but if an average peat is worked, that fuel is paid for by the sulphate produced. Assuming 4% yield of sulphate having a market value of $50 for each 100 tons gasified peat, this would give $200 credit towards the expenses, and thus reduce the fuel economy to a question of minor importance.

A complete factory, consisting of wet-carbonizing plant, briquetting plant, and gas producers with ammonia recovery, will shortly be working in England. Another plant is being built in Germany for working on a peat-bog there.

PRODUCTS OF THE NEW PROCESS.—In the foregoing portion of this paper the principles and advan-

TABLE VI.—CALORIFIC VALUES OF RAW AND COKED PEATS.

	Ratio dry substance to moisture in sample.	Calories per Kg.	B. T. U. per lb.
Pressed cakes, fresh—			
Wet-carbonized at 220° C., 50 atmospheres	2:1	4,008	7,210
" at 200° C., 50 "	1⅔:1	3,495	6,290
" at 180° C., 40 "	1:1	2,707	4,870
" at 220° C., 40 "	1:1	3,050	5,490
Pressed cakes, air-dried 1 week—			
Wet-carbonized at 120° C., 50 atmospheres	4:1	4,785	8,630
" at 180° C., 50 "	4:1	4,370	7,870
Raw peat—			
Air-dried to 25 % moisture	3:1	3,546	6,390
Air-dried to 33 % moisture	2:1	3,218	5,800
Air-dried to 37½% moisture	1⅔:1	2,810	5,060

tages of the wet-carbonizing process have been described. The products have also been the object of careful investigation.

The Press Cakes.—These are to be regarded as the first crude product. They contain a fraction more moisture than air-dried peat, one-fourteenth to one-seventh of the original water remaining, but the higher calorific value of the dry substance counterbalances the reduction caused by the higher contents of moisture.

Although it is not proposed to use the press cakes as a fuel, it is of interest to compare their fuel value with that of peat in an air-dried condition. Three of the press cakes from the experiments recorded in the pressing diagram were directly tested in the Mahler bomb calorimeter with the results shown in Table VI. The peat-pulp used for these determinations contained, as mentioned, seven parts of water to one part of peat.

Briquettes.—The appearance of a briquette of wet-carbonized peat is very similar to that of a lignite briquette. It has a black glossy surface, and is very compact. During the wet-carbonizing a wax of paraffinous nature is liberated which serves as a binder for the particles. There is 3 to 4% of this wax in wet-carbonized peat. For practical purposes the briquettes can be regarded as impervious to water.

The briquettes from wet-carbonized peat burn with a long luminous flame and are quickly lighted. Thin pieces can be lighted with a match like wood. With an ordinary chimney draught they burn without soot or smoke. A fire of briquettes is more like a logwood fire than a coal fire. The composition of the briquettes is shown in Table VII.

Sudden heating and cooling do not disintegrate briquettes of wet-carbonized peat, and they can be burned under locomotive boilers without any change being made in the construction of the fire-boxes or grates.

At a trial firing of the locomotive of a shingle train, running at full speed, briquettes of peat, wet-carbonized at 155° C., produced 6.2 lbs. of steam at about 130 lbs. pressure for each lb. consumed, whilst coal used on the same engine generated 6.7 lbs. of steam under similar conditions. No smoke nor cinders from the chimney were observed. The ash or powder amounted to 4.5%. With briquettes of higher carbonizing temperature still better results may be expected.

Charcoal and Coke from Peat.—There are in Europe at present no more than six known localities where charcoal or coke, from peat, is used in blast-furnaces; four are in Germany and Austria and two are in Russia (Perm and Warschini, Ural). At none of these places is peat charcoal used alone. The uncertainty of the supply compels owners of furnaces to keep a considerable store of wood charcoal. Another drawback is the comparatively low crushing strength of the charcoal from air-dried peat which is not strong enough to carry the weight of the ore charge in the furnaces. The porous condition of air-dried peat of average quality makes the coal very brittle. To obtain coal with sufficient strength good mature peat has to be selected and submitted to a special treatment somewhat differing from the ordinary air-drying process. Otherwise the result with peat coal has been highly satisfactory, and the low percentage of sulphur makes it an excellent substitute for wood charcoal.

Now that the wet-carbonizing process makes it possible to obtain a regular supply of peat material, it becomes a question of great importance to know the qualities of the products resulting from charring or coking such peat. The experiments and trials with wet-carbonized peat have only recently been completed, and manufacture on a large scale has not yet commenced. The wet-carbonized material at disposal for trials in this direction has therefore been rather limited, but the quantities available have been sufficient to make the results of the trials reliable.

Two kinds of products are obtainable: one a light porous product, similar in appearance to wood charcoal, which may be called "peat charcoal," and the other very heavy, and similar in appearance to coke, but without the large pores. This latter product the author calls "peat coke," to distinguish it from the former.

The first material tried was taken from the press cakes of wet-carbonized peat obtained at 180° C. Samples were charred in retorts and large iron crucibles containing 1 to 5 lbs. of the material. The dried press cakes were comparatively strong, but after being charred in retorts the coal could be crushed to powder between the fingers. Powdered and pressed into the crucibles, they did not bind. Better results were obtained with peat cakes containing 40 to 50% water. Pressed into the crucibles they bind well, giving charcoal in large pieces. A rapid heating here gave better results in this case than gradually increasing the heat. It is evident that the water present had some chemical action upon the peat during the charring.

Altogether 42 charring experiments and tests have been carried out. The principal results are summarized in Table VIII.

The peat used was wet-carbonized at 180° C. (except in yield, no difference can be expected in wet-carbonized peat produced at different temperatures).

Samples of charcoal from the press cakes were tested as regards crushing strength. To obtain regular pieces, cubes and oblong pieces were cut out of the material with a fine saw.

The average crushing strength according to these tests is 37.8 kg. per sq. cm. (538 lbs. per sq. in.) in the direction of the fibrous structure and at right angles thereto. Two samples of wood charcoal tested in a similar way gave an average crushing strength of 72.5 kg. per sq. cm. (1,030 lbs. per sq. in.) in the direction of the fibrous structure and 10.8 kg. per sq. cm. (153 lbs. per sq. in) against.

The poor results from the crushing test gave the idea of charring the material in briquetted condition. Hereby the heavy coke mentioned was obtained. To produce the best, hard, clinkering coke, it was found to be necessary to heat the briquettes slowly, allowing the gases proper time to escape. The result was a fine porous coke having a volume weight of 30 to 32 lbs. per cu. ft.

The specific gravity of the peat coke was determined in alcohol, thereby carefully filling the pores. The figure obtained as true specific gravity was 1.585. The porous coke showed an apparent specific gravity equal to 1.070, with 35.9% of volume, fine pores.

In coking, the briquettes shrink 40 to 50% of the original volume. By a number of tests the yield of coke was found to be 44 to 45% in weight.

Analyses of three different samples, made from peat specially selected for its low percentage of ash, gave results of Table IX.

The coke from briquettes of wet-carbonized peat is remarkably strong. The crushing strength in a number of determinations ran from 230 to 400 kg. per sq. cm. (3,260 to 5,670 lbs. per sq. in.) and the tensile strength was found to average 36 kg. per sq. cm. (512 lbs. per sq. in.)

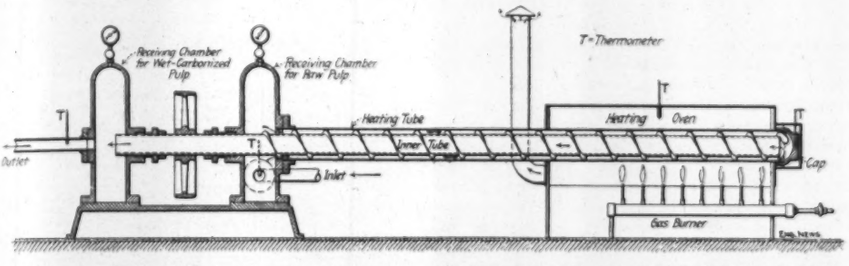


FIG. 4. SECTION THROUGH EXPERIMENTAL APPARATUS FOR DRYING PEAT; EKENBURG PROCESS.

TABLE VII.—COMPOSITION OF COKED-PEAT BRIQUETTES.

	Carbonizing temp. deg. C.	Ash, %	Moisture, %	Heating value, cals. per kg.	B.T.U. per lb.
Small briquette	200	3.8	2.9	6,280	11,300
Large briquette	180	3.7	4.1	5,754	10,350
	155	4.46	..	5,136	9,250
For comparison—					
A briquette of air-dried peat, German make	..	4.1	14.5	3,910	7,040
Av. English steam coal	..	5.2	6.5	8,000	14,400
Av. German coal	..	6.0	6.5	7,400	13,300
Lignite briquettes	..	9.1	12.6	4,960	8,930
Coal briquettes, Belgian	..	6.2	7.5	7,800	14,050

TABLE VIII.—PEAT CHARCOAL TESTS.

Percentage of water in peat.	Net yield.	Character of charcoal.
0	36.1%	Very soft and friable.
50	32.4%	Hard.
5	34.1%	Powdery.
20	33.7%	Soft and friable.
40	32.9%	Hard.

TABLE IX.—COMPOSITION OF PEAT COKES.

	Sample No. 1. Per cent.	Sample No. 2. Per cent.	Sample No. 3. Per cent.
Ash	4.10	5.6	7.8
Phosphorus	0.01	0.017	0.03
Sulphur	0.30	0.16	0.34
Carbon	88.1	84.4	..
Hydrogen	1.9	2.6	..
Oxygen and Nitrogen (balance)	6.7	7.4	..

Water-Works Appraisements in Missouri and Kansas.

By CLINTON S. BURNS,* M. Am. Soc. C. E.

The popular wave in favor of municipal ownership of water-works and electric lighting plants, that has been sweeping over the country at large, has had its share of adherents in the Central West, and especially in Missouri and Kansas.

The firm of which the writer is a member, has been called upon to make appraisements for 19 different municipalities throughout Kansas and Missouri during the past decade, having represented the municipal authorities in each case. It is therefore but natural that special study looking to the interest of the municipalities has been made in the effort to secure appraisements that would in every case be fair to the municipal authorities and yet not unjust to the corporation interests. It is therefore especially gratifying to note that in this number of appraisements made especially for the city authorities in each case, the results of the appraisements have been accepted by the water-works companies in nine different instances.

In each instance the general method of making appraisement has been practically the same and has been based upon court decisions, so far as court decisions are available covering the special points at issue. The physical value of the property has been assumed to be what it would cost to duplicate the plant at the prices current at the time the valuation was made, less a proper amount for depreciation. The prices current at the time of the valuation seem to be a fairer basis on which to determine the present value than an average price for a term of years preceding the valuation, for the simple reason that the company having the property for sale is not injured thereby in case the prices are abnormally low at the time, for the opportunity exists to reinvest the proceeds of the sale at current prices.

On the other hand, if current prices are abnormally high, the city desiring to purchase the property is not injured because of the fact that the rates of interest are usually correspondingly lower at times when construction materials are high, and if the voters elect to purchase the property at such a time, they should pay the current rates for labor and material entering into the construction of the plant.

A brief description follows of each of the nine appraisements referred to above.

ABILENE, KANSAS.—In December, 1905, the city authorities of Abilene, Kansas, desired to ascertain the value of the water-works plant as a preliminary to determining whether or not municipal ownership of the water-works plant would be desirable for Abilene. Accordingly, the writer was engaged to make a report to the city authorities concerning the value of the water-works system.

The distribution system consists of approximately ten miles of cast-iron water pipe, from 4 to 12 ins. in diameter, and about two miles of 2-in. galvanized iron pipe. The water-supply is of unusual quality, being obtained from sand springs about four miles from the city. This water is reputed to be the best water-supply in the State of Kansas; in fact, travelers who have gone west through Kansas over the main line of the Union Pacific Ry. doubtless recall that the dining car company calls special attention to the fact that the drinking water served is from the famous sand spring at Abilene. The water, which is exceptionally soft, is clear, absolutely free from sediment, and almost free from mineral impurities.

*Member of the firm of Burns & McDonnell, Civil, Hydraulic and Sanitary Engineers, Scarritt Bldg., Kansas City, Mo.

There was no dissatisfaction with the service offered by the water company, but the move for municipal ownership seemed to be very strong, simply on the broad general grounds of the city's desiring to get control of the public utilities. The company had always given very fair service and the only discontent in the city arose from the fact that extensions were desired in certain quarters of the city where the company did not feel justified in extending the mains without a renewal of its franchise. The report of the value of the plant submitted to the city officials by the writer was in turn submitted to the water company, and, after some few months of preliminary negotiations, a sale was agreed upon and the property transferred to the city on the basis of the figures submitted in the valuation.

BELOIT, KANSAS.—The appraisement of the water-works plant at Beloit was made in October, 1907. The conditions at Beloit were entirely different from those at Abilene, as there was a strong feeling of dissatisfaction among the water consumers on account of the extremely unsanitary condition of the water-supply. The water was taken from the Solomon River at a point almost immediately below a deep drainage ravine, which carried the surface drainage from quite a portion of the populated district of the city.

The writer submitted a report to the city officials, giving a valuation of the property, and a deal was consummated between the city authorities and the water company on the basis of the valuation submitted. The city immediately took steps to improve the water-supply and voted bonds for extensions and a new water-supply. It was found that prospects for well water-supply were sufficiently encouraging to justify moving the location of the plant about 1½ miles, where a well water-supply has been secured.

BOONVILLE, MO.—In February, 1903, the city officials of Boonville desired a report on the value and condition of the water-works system with a view to the purchase of the same by the city. The movement for municipal ownership at Boonville was actuated by the fact that the city desired to have filtered water, and also by a feeling on the part of many of the water consumers that the water rates were unnecessarily high.

The water-supply at Boonville is taken from the Missouri River and pumped into large settling basins, having a storage capacity of from 10 to 15 days under average consumption and, until the plant was taken over by the city, the water was supplied directly to the consumers from these large reservoirs by gravity. One point of dissatisfaction was that the reservoirs were not high enough to supply the entire populated district of the city, as some of the finest residences were above the level of the reservoirs. As soon as the report of the valuation of the plant was submitted to the city officials by the writer, negotiations were taken up with the water company and an agreement was reached, after due consideration, at approximately the figures submitted in the valuation.

The city thereupon installed a gravity filtration plant. The water is taken direct from the large storage reservoirs and passed through the gravity filters, from which it is then distributed by gravity as before, with the following exception: A water tower 120 ft. in height was erected and is kept full of filtered water, by means of a steam pump located in the power station at the river bank, through a system of pipes and by-pass valves. The purpose of this tower is two-fold: first, to keep in reserve a sufficient quantity of water to give fire pressure whenever desired, and second, to supply water to that portion of the residence district which is too high to be served by the gravity pressure from the filtered water reservoir. By simply opening a valve, and thus connecting the water tower with the general distribution systems, a fire pressure of from 100 to 125 lbs. per square inch can be maintained until the pumps are started.

EL DORADO, KANSAS.—In May, 1905, the city officials of El Dorado were struck by the popular wave of municipal ownership. The valuation of the El Dorado plant was completed and a report submitted by the writer, and within a short time thereafter negotiations were completed on the basis of this report which resulted in the municipal ownership desired. The plant has since been improved, the service extended and a new water-supply installed.

INDEPENDENCE, KANSAS.—The city of Independence had voted bonds for the construction of a new plant and the firm of which the writer is a member had been called upon to design it. It was strongly recommended that the city make an effort to purchase the old water company's property prior to the installation of the new works, and following this recommendation the city asked for a report on the valuation of the old company's property. This report was submitted to the city and was accepted by the water company prior to the time when the city commenced the construction of the new plant. The old distribution system was incorporated into the new, but the old water-supply was entirely abandoned and a new station installed, taking water from the Verdigris River, pumping the same into storage reservoir and running through gravity filters.

McPHERSON, KANSAS.—This valuation was made in May, 1908, and on the basis of the figures submitted in the valuation the city officials negotiated with the water company and purchased the plant some two months later at approximately the amount of the appraisement.

MINNEAPOLIS, KANSAS.—The appraisement of the Minneapolis plant was made and submitted to the city council in 1907. It took about six months for the city officials to complete the negotiations for the purchase of the plant, but this was finally accomplished on the basis of the report and valuation submitted. The service given by the water company at Minneapolis was entirely satisfactory, and the city officials stated that the chief reason for the desire for municipal ownership was the fact that the city wanted to install a system of sewers and was unable to secure a reasonable rate from the water company for the water necessary in flushing the sewers.

PAOLA, KANSAS.—The city of Paola was one of the first in the state to agitate the change from private to municipal ownership. The valuation and report first submitted to the city of Paola by the writer was in 1901. The appraisement was at first attacked and questioned by the water company and negotiations were under way for a number of years before an agreement was finally reached between the city and the company. The property was finally purchased by the city at the amount of the appraisement first submitted, corrected for the change in current prices of materials at the date of transfer.

TRENTON, MO.—The valuation of the Trenton plant was made in 1906 and a report submitted to the city officials. Trenton at that time was blessed with a city council many of whose members had ideas of their own regarding how an appraisement should be made. Negotiations were opened with the water company on the basis of the report submitted by the writer, modified, however, in the following particular. The city officials conceived the idea that in streets that had been paved, there was a corresponding depreciation in the water-pipe due to the paving.

The argument advanced was that the water main could serve the property just as well if laid in an alley in the rear of the property as though laid in the street, and that if laid in the alleys it would be easier to maintain, easier to tap and less expensive to repair and would save digging up the pavement in a great many places. Therefore it was regarded as a decided disadvantage to the city to have the water-pipe under the paved street if the same could possibly be avoided. So far as known to the writer, this question has never been specially argued or passed upon by the courts, but the city officials of Trenton used the argument with such force that they finally purchased the water-works system at $2,000 less than the valuation submitted by the writer.

While in nearly every instance the valuation submitted has been far less than the value first claimed by the water company, yet the fact that, in the 19 valuations cited, nine have finally been accepted by both parties interested is certainly gratifying to the appraiser, for such a recognition of his efforts to arbitrate a disputed question in a fair and impartial manner cannot but be heartily appreciated.

It is doubtful if any municipality desires unnecessary litigation, nor can it afford to submit to the unjust claims of a greedy corporation. It should be the desire of every municipality confronted with these vital questions of public interest to have a report submitted by an engineer of recognized authority in questions of valuation, who is known to be likewise fair and impartial.

A Combination Steel and Rawhide V-Belt for Power Transmission.

For power transmission work, the V-shaped type of belt (with grooved pulleys) has special advantages, and a belt of this type is now being introduced which, it is maintained, combines great strength and capacity with durability. It consists of a steel link chain and a rawhide casing; the chain forms the core and takes the strain, while the rawhide forms the friction surface. Rawhide is used in preference to leather, as it has a higher coefficient of friction. When free from strain (as in this case) it is very lasting and can stand dampness without injury.

The construction of this chain belt is shown in Fig. 1. The chain links are of pack-hardened machine steel, and consist of alternate pairs of

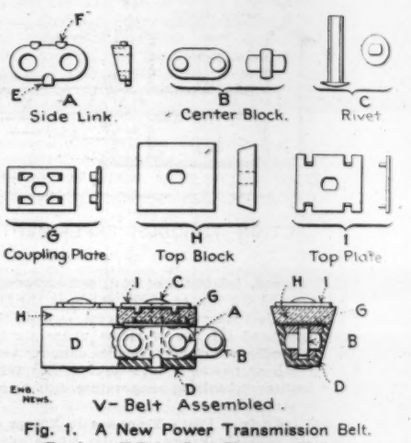


Fig. 1. A New Power Transmission Belt.
(Peerless V-Belt Co., Chicago, Makers.)

side plates (A) having holes drilled to receive lugs on the ends of two adjacent single drop-forged center-plates (B). The outer faces of the side plates are inclined to the slope of the pulley groove. Between the side plates, and fitting between the ends of the center plates is a vertical rivet (C) of flattened or oval section. This is somewhat thicker than the center plates, so that it acts as a spacer to prevent the side plates from binding upon the center plate. The bottom of the rivet passes through a continuous strip of rawhide (D), which is of such width as to be bent up against each side of the chain and thus fit the sides of the groove in the pulley.

In order to prevent the rocking of the chain links (as they pass to and from the pulley) from wearing the rawhide, there is a projection or lug (E) on the middle of the bottom of each side plate, which keeps the rawhide from close contact with the ends of the plates. The rivet head also grips the rawhide against the lugs, leaving it practically free at the ends of the links so that the latter can rock inside the rawhide casing. Lugs (F) on the tops of the side plates receive slotted coupling plates (G), having prongs to hold the top block (H). On top of each link is a rectangular piece of rawhide, leather or friction paper (H), secured by a circular or rectangular top plate (I) under the head of the rivet. The sides of these top blocks (forming a sectional belt) are beveled to fit the

groove in the pulley, and the edges of the continuous rawhide strip fit beneath them, as shown in the cross-section.

The construction is such as to give a strong and flexible belt, which runs noiselessly, has a high degree of adhesion and will not stretch. It is run quite slack, and thus reduces the strain on the shaft bearings, but has considerable adhesion upon the pulley due to its wedge action against the sides of the groove. The groove in the pulley covers an angle of about 28°, and is of such depth that the belt cannot touch the bottom and thus relieve the wedge action. As the belt enters the pulley it tends to wedge itself into the groove, but automatically releases as it leaves the pulley, without any binding or grip which would involve loss of power in breaking the contact. The belt is said to be specially valuable in driving closely spaced shafts. The rawhide facing makes a noiseless belt, and protects the chain from dirt and dust, while the steel core prevents stretching.

The belt is made in two sizes, ⅞-in. and 1¼ ins. wide. These will transmit about 1 HP. per min. for each 200 ft. and 130 ft., respectively, of lineal contact for ordinary spacing, or a somewhat greater contact for closely spaced pulley centers. The belt can be run at speeds of about 3,000 ft. and 5,000 ft. per min. on small and large pulleys, respectively. In substituting these belts for flat belts, a special grooved pulley rim is used, which can be fitted to the rim of the old flat-faced pulley. The belt requires to be lubricated only about once in three months.

This V-belt has been applied to a number of machines, including air compressors, pumps, refrigerating machines, and electric motors of ½-HP. to 100 HP. At some of the large office buildings in Chicago it is used for motor driven pumps (brine, boiler feed, elevator, etc.) and ventilating fans, while at the Harrison St. pumping station of the Chicago water-works it is used to drive the coal and ash conveyors. An unusual application is its use to drive tanner's drums (large wooden drums in which the hides are treated) at the plant of Gutman & Co., Chicago.

At the Chicago Savings Bank Building, these belts have been substituted for flat belts driving a triplex pump (for the elevators) from a 50-HP. motor. This is shown in Fig. 2. The motor pulleys (one on each end of the shaft) are 11 ins. diameter and the pump flywheels 9 ft. 2 ins. diameter (ratio 1:10). The horizontal distance between the shafts is only 11 ft. and with this close spacing, each 12-in. flat belt had to be pressed down by an idler to give the necessary area of contact on the pulley. The slipping of the belts made it necessary to use a second pump working intermittently, to maintain the pressure. Five 1-in. V-belts were substituted for each flat belt, with the result that slipping was avoided and the one pump was sufficient for the work. Subsequently two of the V-belts were removed, and it is considered that three on each pulley would be sufficient, though four (eight in all) are now in use. This belt drive has been in operation for about four months, and runs at a speed of about 1,900 ft. per min. In another case a single set of three V-belts has been substituted successfully for gears on a motor-driven duplex pump, the gears having been objectionable on account of the noise. The belts have been used also for driving machine tools, and a pair of small emery wheels is driven from a countershaft by a single V-belt running at 3,500 ft. per min. Another belt runs from the countershaft to the main shaft.

The belt is manufactured by the Peerless V-Belt Co., 215 So. Clinton St., Chicago.

FIG. 2. V-BELT DRIVE FOR A MOTOR-DRIVEN ELEVATOR PUMP IN THE CHICAGO SAVINGS BANK BUILDING.

A Labor Partnership in an English Coal Mine.

An interesting experiment in cooperation between labor and capital for the prevention of strikes and the encouragement of thrift among the workmen has been recently proposed by Sir Christopher Furness, a wealthy English colliery owner. "The Engineer" of London gives the gist of this proposal in an address made to the workmen by Sir Christopher on May 21. We reprint portions as follows:

The Wingate Colliery produces one of the best known gas, household, and steam coals in the North of England. At the moment it is yielding about 350,000 tons per annum, and the number of men and boys employed is rather over 1,400. The freehold estate included in the purchase extends to about 1,000 acres, with several hundred houses, comprising a large part of the township of Wingate, and the purchase price of the entire property, comprising the freehold estate, plant, business and goodwill, and a sum of £7,000 invested in Consols, was £175,000. We have vested the whole of these interests in a company, registered under the title of the Wingate Coal Co., Limited, with a capital of £200,000 in £1 shares, a margin being thus provided for expenditure on improvements and developments.

I have to say, therefore, that it would be a source of great satisfaction to us if you will mark our assumption of the control of the Wingate Colliery and Estate by becoming labor co-partners with us in this property; Sir Walter Scott, Mr. J. S. Barwick and myself each to own not less than a quarter of the shares, and the remaining fourth part to be divided up among all the officials and men employed by the company.

What, you will ask, are to be the conditions attaching on the part of the colliery workers to participation in the co-partnership? Here is my answer, divided into sections:

1. While the Board of Directors will retain for the officials of the company the full power to employ men as the circumstances of the moment may determine, the general conditions of working and payment accepted by the Miners' Union will be duly recognized. On the other hand, it is well that it should be understood from the beginning that, in view of the advantages in which employees engaged on the colliery will certainly share, as well as other benefits that may possibly accrue to them, our officials will be under strict injunctions to see that only men of capacity and industry, discreet conduct and sober habits, and regularity in hours shall be retained in the service of the company.

2. Every employee, whatever his status—for according to my standards, laborers have rights equally with other members of the working-class community—every employee, I say, becomes a member of the co-partnery by signifying assent to its principles, and by acquiescing in the regular deduction of 5% from his pay until the shares to be allotted to him, and which he must apply for, are fully paid, thus enabling him to acquire his holding by gradual instalments; and no employee can continue in the service of the company for more than three months unless he becomes a co-partner.

3. The laborer co-partners—who in other respects will be as the workmen of other collieries in the county of Durham, not forgetting the legal rights conferred on employees by the Workmen's Compensation Act—will participate to the extent of their share holdings in such profit as may from time to time be paid in dividends by the company. Large and small shareholders alike will be placed on precisely the same footing.

4. The control of the company's affairs will be vested in the Board of Directors, and no one but the management will possess authority to discharge as well as to engage workmen, with responsibility to the board alone. Alongside this form of administration, however, there will exist a colliery council, composed equally of representatives of the directors and representatives of the employees, which body shall become the repository of information of importance or interest that may be communicated without injury to the company's welfare, shall have power to investigate and bring efforts of conciliation and persuasion to bear upon matters that may come into controversy between employees and employers or their representatives, and shall be entitled, by majority vote, to make representations and offer counsel to the board in matters directly relating to the working arrangements and conditions associated with the colliery. Furthermore, the representatives of the employees would possess the privilege of summoning to meetings of the council, whenever their advice was desired, the officials of their trades unions, who would be entitled to elicit information and to address the council on the subject occupying its attention. But these are points of detail which can be settled in conference subsequently, should you and your fellows resolve to cooperate in the execution of the scheme I am now propounding to you.

5. The above outlined arrangement, alike in its parts and in its entirety, is subject to the cardinal and supreme condition that in acquiescing in it the co-partners, while accepting the hours, wages and other conditions of labor actually secured generally by the employees' trade unions throughout the county, which shall govern this compact, agree to substitute, on the one part for that barbaric instrument the strike, and on the other part for the equally out-of-date instrument the lock-out, conciliation by the Colliery Council, or, this failing, arbitration by a court of representatives of employers and employees, and presided over by the County Court Judge of the district or his nominee, the chairman of such court to be regarded in the last resort as final arbiter in all matters of dispute.

The single sacrifice you would make in return for all these advantages would be the sacrifice of the power to go on strike whenever a bit of temper seized you—for, mark you well, a strike, however limited in its character, would instantly bring the co-partnery to an end, at any rate so far as concerned the strikers, who would cease all connection at any time with the colliery, the term partnership carrying with it a direct responsibility for justice to the interests of other partners which cannot be ignored.

A Modern Oyster Dredge.

By FRANCIS K. WILSON, JR.*

The production and harvesting of the common oyster of commerce has developed from a small and insignificant business of 50 years ago to an important industry at the present time, and as a natural result there is quite an improvement in the present method of dredging oysters from the inadequate method of tonging employed to within 15 years ago, which is still practiced in many remote sections by the small oyster growers.

Probably the greatest and most prolific oyster growing grounds of the United States are those located in Chesapeake Bay and in Great South Bay, that body of water lying south of Long Island and separated from the Atlantic by the Fire Island Reefs. While this article is not intended as a treatise on oyster culture, yet the subjects of beds and planting may be referred to for general information.

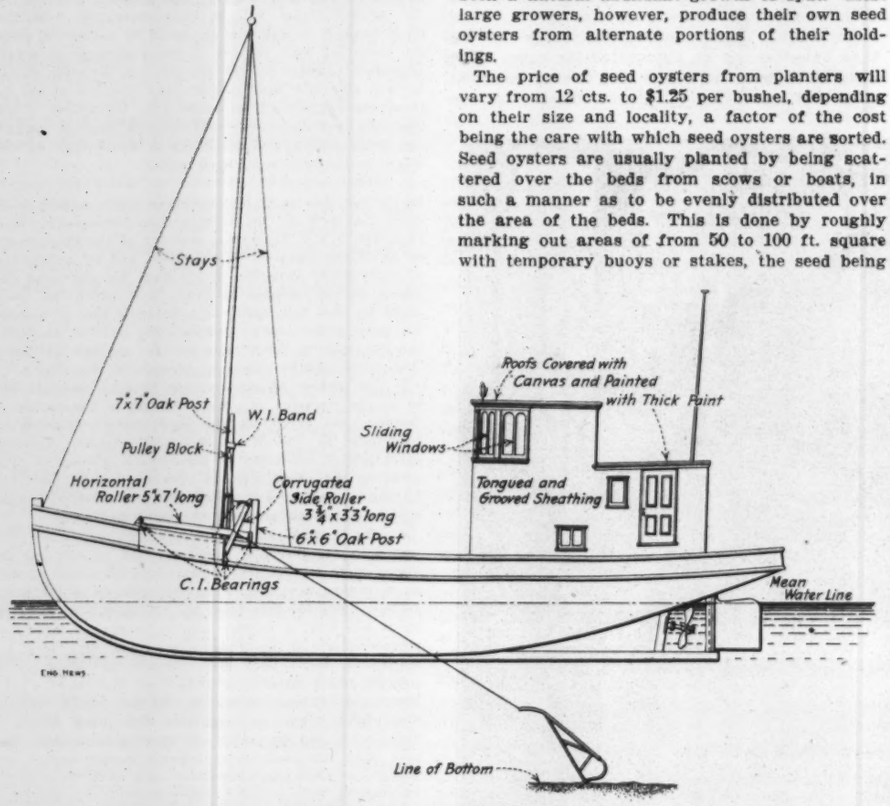


FIG. 1. THE OYSTER DREDGE "J. VAN WYNE."

BEDS.—A bottom having a firm, hard surface is desirable for the proper cultivation of the oyster, and the growers of Eastern coastwise states, if unable to locate such a bottom, usually provide one by means of strewing oyster or clam shells, gravel or coarse sand in such quantities as to give the desired degree of firmness, which may vary largely under different conditions and locations and in the judgment of the grower. With the use of the shells and gravel as above described a twofold object is obtained, (1) the fully developed oyster is prevented from being submerged in the mud, and (2) a place of a suitable nature for the attachment of the "spat" is offered.

At such locations where dredging for harbor or other improvements has been in progress, sandy and gravelly material resulting from such operations may be utilized for the purpose of bottom making to great advantage, giving excellent results at small cost. Such material as above described for bottom making should be deposited in firm uniform layers entirely covering all muddy bottom so that any oysters or spat that may be planted will not be submerged and lost. It is found to be poor economy to use a small amount of material for bottom making. The thickness will vary from 3 to 18 ins., depending on the character of the original bottom. Where a bottom has been properly made, it is seldom that it is required to be renewed for five or six years.

PLANTING.—After proper preparation of the bottom the oysters are planted by one of two methods: (1) Seed oysters may be planted, or (2) cultch may be used to catch the spat which is retained until fully grown. The first method is probably the more practiced and with greater success. Seed oysters range in size from "blisters" to full grown ones, and may be dredged for market in from four to six months after being bedded. Such oysters vary in size from ¾ to 1¾ ins., and may be obtained from regular planters who make a business of furnishing them, or from along the shore where there has been a natural abundant growth of spat. Most large growers, however, produce their own seed oysters from alternate portions of their holdings.

The price of seed oysters from planters will vary from 12 cts. to $1.25 per bushel, depending on their size and locality, a factor of the cost being the care with which seed oysters are sorted. Seed oysters are usually planted by being scattered over the beds from scows or boats, in such a manner as to be evenly distributed over the area of the beds. This is done by roughly marking out areas of from 50 to 100 ft. square with temporary buoys or stakes, the seed being planted by shoveling from the boat or scow. In this way the seed oysters may be rapidly and evenly distributed over the beds. From 350 to 500 bushels per acre is the customary amount of seed oysters required for planting.

The second method of obtaining oysters for planting on to the cultch requires the preparation of the bottom in much the same manner as that previously described for planting seed oysters. The swimming fry in the embryo state readily attach themselves to the shells and pebbles of the sand used in making the bottom. The "mother" oysters from which the fry is germinated are planted approximately 2 ft. apart, always keeping in mind the fact that all the oysters may not be "brooding" oysters, but of one sex only, for a considerable area covered. Some 50 bushels of oysters, of about 250 oysters to the bushel, are usually considered enough to plant per acre of beds to obtain desired results. The fry at this age will measure about 1/100-in. in diameter.

After attaching itself to the shells or other hard bottom material the infant oysters rapidly develop into healthy spat which may be left to mature with proper culling on the beds of original planting or may be transplanted to new beds, as desired.

DREDGING.—As a typical oyster dredge, constructed along modern lines, the "J. Van Wyne," owned and operated by The J. Van Wyne Blue Point Oyster Co., of West Sayville, Long Island, N. Y., may be considered as embodying the results of several years' improvements in the development of this particular and peculiar style of craft.

The principal dimensions of the hull of this dredge are:

Length, over all, 50 ft. 8 ins.; beam, 16 ft. 10 ins.; depth, 4 ft. 6 ins., deck to keel.

Weight, without engines or hoist, 27 tons.

Weight of engines and accessories, 7 tons.

The hull is constructed of well seasoned oak planking on a wooden frame work of ribs well braced to a heavy keel, the whole being of average proportions for members and details of design. The hull is decked entirely over with the exception of the main loading hatch, forward of the cabin, and the space immediately beneath the cabin utilized for engine room. The hull was built by Bernard Coupe, of Patchogue, L. I., and is an exact duplicate in design to a sister dredge, the "Alarm," the only difference being in the make and design of the engines. The latter boat was constructed two years previously and was found to be an ideal craft to meet the requirements for oyster dredging. The hull of the "J. Van Wyne" was constructed about a half-mile inshore from the Patchogue River, and upon completion was transported to the river by means of rollers and horses, and launched in the usual manner for craft of this size.

DREDGE EQUIPMENT.—The dredge is equipped with a 30-HP., triple-cylinder four-stroke three-cycle "Globe" gasoline engine, built by the Pennsylvania Iron Works, of Eddystone, Pa., and especially adapted for this class of work, being designed with an extra heavy base to reduce the hull vibration to a minimum. The engine is direct-connected to a 36-in. three-blade propeller, fitted with reverse and speeding attachments. One of the features of the engines is in having each cylinder a separate casting, so that anyone of the three may be removed from the base to facilitate repairs independently of the other two. The ignition is controlled by a spark adjuster connected to each cylinder, all three of which are controlled in the pilot house by one main lever. As the engine is operated at variable speeds, the sparking device is controlled automatically by the speed regulating device. The engine is fitted with reciprocating air and water pumps. The air pumps are connected to a supply tank located close underneath the decking on port side, forward, giving ample supply of air at 100 lbs. pressure at all times for whistle service and air starting if desired.

The double-drum hoisting device was furnished by John Cameron, of Greenport, L. I., and consists of two simple drums, one for the port, and one for the starboard scoop dredge, mounted loose on a transverse shaft and each caused to revolve on this shaft by means of a clutch operated from the pilot house by means of a half-inch rope, reeded through small blocks. The double hoist is driven by one longitudinal shaft, connected to the hub of the balance wheel of the engine by means of a simple form of universal joint, being engaged or disengaged by a friction clutch operated from the pilot house by means of a half-inch rope reeded through small blocks. The drum clutches are also each arranged for operating from the mast, by the deck hands, in case the operation of the dredge may demand the whole attention of the pilot. All ropes for operating the various levers described are fitted with convenient handles.

The chain cable for each scoop is attached directly to each drum and is made of standard ⅝-in., closed-link chain. From the drums, the chain cable is passed forward to the step of the mast where a 7-in. square post is also stepped to the keel and extends about 9 ft. above the deck. At the base of this post each chain cable is reeded through a fixed block and extends up the side of the post through a heavy pipe about 2½ ins. in diameter, and, after passing out of the top of this pipe, is reeded through a heavy block hooked to a band at the top of the post by an eye secured to same. After being reeded through a block on each side of post, the cables each pass over the sides of dredge, bearing on horizontal and verti-

*104 Woodland Ave., Coatesville, Pa.

cal side rollers. A scoop is attached to the end of each chain.

The scoops are built from commercial sizes of flat and round iron of the design and dimensions shown on the drawing and are covered over the entire outer surface with the exception of the mouth with net of link chain. This is made of alternate round net links and oblong binder links, all of 5/16-in. stock. The round links are closed and the oblong links are open for ready attachment and repairs. The cross-bar at the mouth or large end of the scoop is fitted with from 16 to 24 spike-like teeth, which are extended downward obliquely towards the frame of scoop proper. These teeth go through the bar up to a shoulder on it, and are sometimes riveted over and sometimes threaded and held by a nut. Owing to the shape of the scoop, like a huge claw with small sharp fingers and a capacious closed palm, it will invariably turn bottom downward in the proper position for operation, due to this shape and to the position of the center of gravity.

The operation of the dredge is comparatively simple, all apparatus being controlled from the pilot house.

The cost of this dredge with equipment was as follows:

Hull, complete	$3,000.00
Engines, tanks, steering rigging and air system, installed complete	1,650.00
Double drum friction hoist, including operating apparatus, installed complete	750.00
Small interior fittings, etc.	175.00
Total	$5,575.00

The trial trip of this dredge was made on Jan. 2, 1908, in Great South Bay, which was covered with about an inch of ice at the time. After this date the dredge was put in regular commission. The engines, hoisting and all auxiliary apparatus were installed in the above dredge under the supervision of the writer, as erecting engineer for the engine builders.

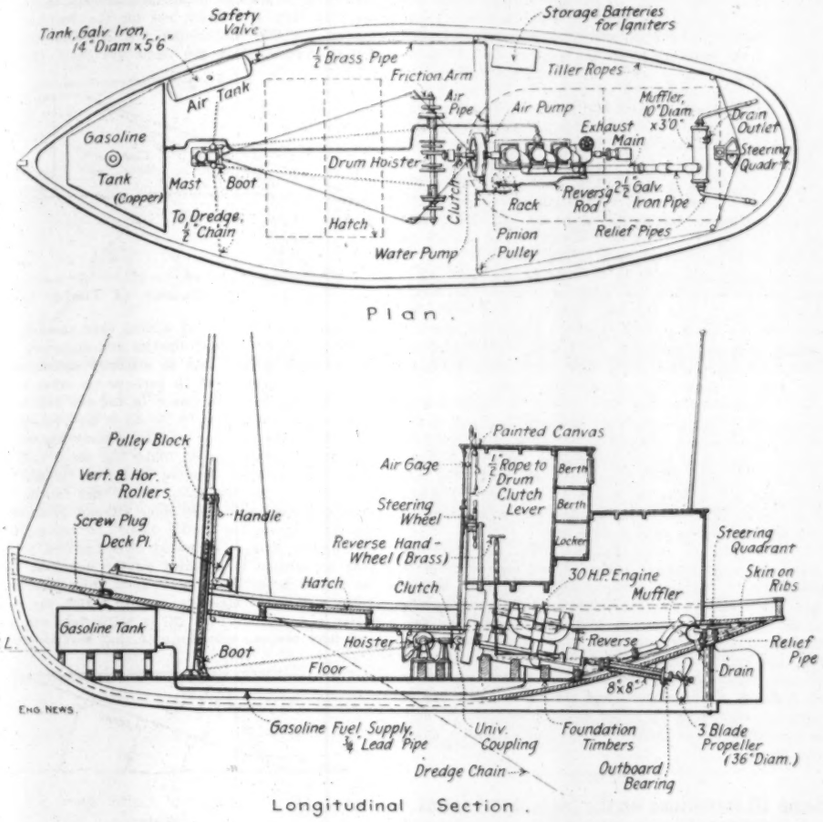


FIG. 2. HOLD PLAN AND LONGITUDINAL SECTION OYSTER DREDGE "J. VAN WYNE."

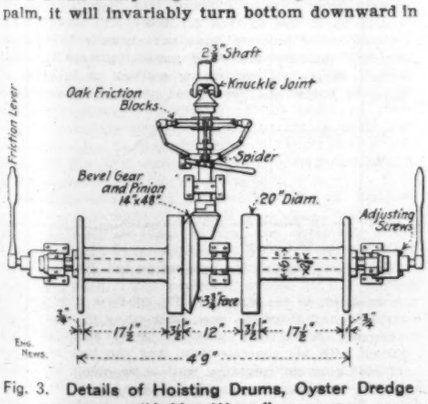


Fig. 3. Details of Hoisting Drums, Oyster Dredge "J. Van Wyne."

Highway Maintenance and the Missouri Law for County Engineers.*

By WILL DOWELL.†

In Missouri, the municipal affairs of each county are under the direction of a so-called county court, consisting of three judges elected by the people. In most counties the county court has general supervision of all road affairs.

In 1907, the legislature passed a new road law and by separate enactments provided for the appointment of a state highway engineer and for county highway engineers.

The office of state highway engineer is purely advisory. He is appointed by and is under the direction of the State Board of Agriculture, and his duties are to advise with county courts, township boards and county engineers.

County highway engineers were to be appointed by the several county courts in January, 1908, and every two years thereafter. They were to receive such compensation as might be fixed by the county court, not less than $300 nor more than $2,000 per annum. The engineer must be a resident of the state of Missouri, must be skilled in the laying of drains, in bridge, culvert and road building, and in general road work, and have a practical knowledge of civil engineering. He may be removed from office by the county court upon the grounds of incompetency, neglect of duty or for any other good and sufficient cause. He must devote his entire time to the duties of his office and not engage in any other vocation, but the county surveyor may be appointed to the office if competent, and may receive such fees as may accrue by virtue of the surveyor's office in addition to his salary as engineer.

The county engineer is custodian of all road tools and machinery belonging to the county and to the several road districts. He has direct supervision over all roads of the county and over all road overseers and of the expenditure of all county and district road funds made by the overseers. He has supervision over the construction and maintenance of all culverts, bridges and roads, and no county court may issue warrants in payment for road work or any other expenditure by road overseer or in payment for work done by contract until the claim therefor shall have been examined and approved by the engineer.

The engineer must personally inspect the roads, culverts and bridges of each district as often as practicable, and on complaint in writing of three freeholders of the bad or dangerous condition of the roads, culverts or bridges, or the neglect of duty by the overseer, or the neglect of any contractor on roads let by contract, it is made the duty of the engineer to at once visit said road and investigate the complaint and if found necessary to at once cause such road to be put in good condition.

He must call a meeting of the overseers of his county at some date between March 1 and 15 of each year, for the purpose of instructing them in the best and most economical method for working the roads, and the road overseers must follow the plans and instructions of the engineer in all matters pertaining to the roads and road funds of his district. Should one fail or refuse to do so, the engineer may suspend him and at once report the matter to the county court, who, upon hearing may remove such overseer from office. The engineer must use his best discretion as to the manner of keeping the roads in repair and may direct any overseer to enter into contract with suitable parties to maintain any road by means of the road drag or any other plan he may deem expedient.

The road overseers are appointed by the county courts or township boards for a term of one year and receive not less than $2 nor more than $3 per day for the time actually and necessarily employed as overseer, and before entering upon their duties, must give bond to the county court or township board. In all other respects they are accountable to the highway engineer. Each road overseer is required to file with the engineer, on the first of each month, a detailed statement of his transactions as road overseer, showing amounts collected by him and from whom collected, and the amounts disbursed, and on what account; also the work done (including the amount of his own work), when and where done.

This law is very loosely drawn and more loosely observed; 13 counties in the state failed to appoint highway engineers, and so far as I can learn only about one in five of those appointed were competent. In some cases really competent men were appointed, but the salary fixed by the county courts was so small as to practically defeat the purpose of the law. In some counties the salary was fixed at the minimum ($300), and the engineer, (who in such cases was usually a political pet), was given to understand that he was expected to do nothing. It is needless to say the instructions were strenuously followed.

In Jackson county (in which Kansas City is situated) the salary was fixed at $600. The appointee was an able man, however, and did work worth at least $200 per month until he found the office was a source of loss instead of profit and resigned.

In one case the court fixed the salary at $1,200, and one of the judges, a young farmer who could not tell the difference between a vernier and a stadia board, promptly resigned and was appointed engineer. In an-

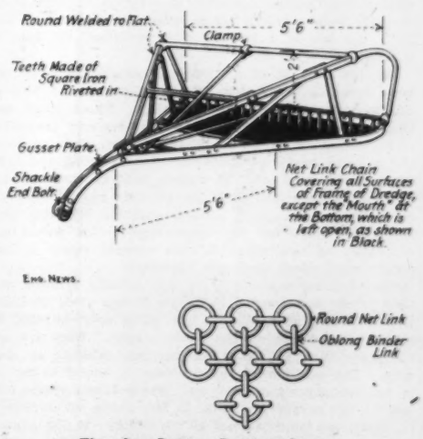

Round Welded to Flat
Clamp
5'6"
Teeth Made of Square Iron Riveted in
Gusset Plate
Shackle End Bolt
Net Link Chain Covering all Surfaces of Frame of Dredge, except the Mouth at the Bottom, which is left open, as shown in Black.
5'6"
ENG. NEWS.
Round Net Link
Oblong Binder Link

Fig. 4. Oyster Dredge Scoop.

*Abstract of a paper in the 1909 "Proceedings" of the Illinois Society of Engineers and Surveyors.

†County Engineer, Coffeyburg, Mo.

other county where the salary is $1,200 and the appointee is a retired farmer, the engineer told me he could do nothing but urge the farmers to drag the roads free of charge—a work that was being effectually done already by the township boards. The engineer knew absolutely nothing of what was being done by his overseers, received no reports from them, has never called a meeting of overseers and allows the township boards to pay for work without his approval. In fact, in the 12 months he has held office he has never discharged a single duty imposed on him by law.

The state highway engineer, Mr. Curtis Hill, says in one of his bulletins:

Some counties are so indifferent to this law affecting road affairs that they ignore it altogether. Other courts have made the salary so meager that they virtually block the intent of the law; others put the position up for auction to the lowest bidder; and others would be better off without any appointment at all, for they have appointed, as county engineers, men who are as indifferent to the road problems of their county as the county court itself. It is only fair to state that in these places the system will be called a failure.

From a number of counties which have tried to carry out the law, however, come reports of good work done under the new law. In Ray county, 150 new road drags have been put in operation at a cost of $4.70 per drag. Franklin county has 200 miles of road under drag contract at a cost of $4 to $8 per mile. In Crawford county, roads have been changed to better locations. At one place the overseer had contracted for lumber for a culvert at a cost of $125. The engineer canceled the order and erected a concrete culvert at a cost of $25. Finding one of his overseers grading with one team and 12 men he put out two more teams, discharged six of the men and with his force did six times the amount of work per day accomplished before. The county court of Audrain county reports that they can pay their engineer $2,000 per year and save money over the old method of working the roads.

There are a number of such reports, tending to show that the law is a success when properly enforced. The great defect appears to be that the administration of the law is not far enough removed from politics. This defect will perhaps be remedied by the legislature. I have suggested the necessity for a law creating a state board of examiners for county engineers and fixing the minimum salary at $2,000, making the requirements such that only $2,000 men can pass. This would at least take the administration of the law from the politicians and place it in the hands of engineers.

Discussion.

Mr. C. Older (Bridge Engineer of the Illinois Highway Commission).—We spend about $5,000,000 per year upon country highways in Illinois. The unit of administration is the township, of which there are about 1,500, and the work in each township is in charge of three township commissioners elected by the people. Thus about 4,500 road officials handle this $5,000,000. It is a notorious fact that the money expended on highways outside of corporate limits is very largely wasted. It is also a fact that the supervision performed by the 4,500 highway commissioners costs about 25% of the total expenditure for roads and bridges.

Practically half of the money (about $2,500,000 a year) is spent in the maintenance and renewal of bridges. Much of this money is wasted and structures are built that are unsafe. We receive reports every few days during the threshing season of traction engines going through bridges, often accompanied by the loss of life. It is not merely a matter of expenditure, but also of making provision for public safety.

For the past 15 or 20 years a certain township had been spending for bridges alone an average of half of the money raised in that township. Three years ago they secured the services of an engineer and thereafter built permanent bridges. In three years they replaced all of their small, unsatisfactory, costly wood and steel bridges with permanent structures built of concrete with a resulting reduction of $1,500 in their annual expenditures for bridges. It is obvious that the township now has $1,500 more for road improvement that would not otherwise be available. It also secures safety to the people who travel over the highways.

The township commissioners are usually farmers and they cannot be expected to handle bridge work, at least, in an intelligent manner. The same may be said as to the expenditure on the roads proper. They are not engineers, but yet have engineering subjects to deal with. The solution of the problem, it seems to me, is to put this matter of road and bridge construction, outside of the corporate limits, in the hands of engineers, changing the unit of road administration to the county in place of the township; and in each county provide a county engineer, who shall have control of all matters pertaining to roads and bridges.

Prof. Talbot (University of Illinois).—I used to be a strong advocate of creating the office of county engineer, who should have charge of everything. I am not a believer in it now. We ought to be careful how we criticize the work that is being done on the state highways. We must bear in mind the conditions and limitations under which it is done and think whether we as engineers could do it better. The amount of money available for improving the roads is very small, and while there must now be some waste and a great deal of incompetency, yet much is being done with the money available through the mud sections of our state in making the roads better.

I doubt very much whether an engineer, with the amount of money available for such purposes, for his own salary and for maintenance, would be able to improve things very much. I am not talking about the construction of macadam roads or other improved roads or the building of bridges, which require skilled supervision. I am speaking about the general work of highway repair, scattered as it is, throughout the townships and under conditions which are largely local.

Mr. D. W. Mead (Consulting Engineer).—About 1887, I was elected county surveyor of Winnebago county, and at that time it seemed to me that there would be a considerable advantage to the county and the conditions, if the county surveyor was made county engineer, and had charge of the general road work carried on in the county. Greater familiarity with the conditions that prevail in regard to road improvements has caused me to take quite a different view of this matter.

In the main, the work to be done by the town highway commissioners is the work of repairs and minor improvements. The highway commissioners are local men who are familiar with the local conditions and can usually make such repairs at the lowest possible expense. They have, as a rule, very little to do with anything that requires high-grade engineering work.

It is undoubtedly true that extensive improvements should not be left in the hands of these men, but should be under competent engineering supervision. I believe, however, that it is wholly inexpedient, even if it could be done, to take from these men the work they are doing and put it into the hands of engineers. I doubt if it could be done under engineering supervision as well and as cheaply as it is done now.

By this I do not mean that the larger and more extensive work of roadway improvements can be properly supervised by highway commissioners, but I do believe that the ordinary run of highway work is of such a nature that you cannot, to advantage, spread the services of an engineer over the many minor jobs which are done by these men. Some plan for the subdivision of this work, leaving the work of minor repairs to the highway commissioners, and placing any new line of extensive improvements under engineering control, may be advisable, but it should first be studied with a great deal of care.

Some Observations on the Stability of Dams.*

By J. F. JACKSON,† Assoc. M. Am. Soc. C. E.

In view of the rapidly growing interest in the subject of water power development and reservoir storage of water for various purposes, it has seemed to the writer opportune to present for discussion some more or less unorthodox observations on the manner of calculating and constructing the various generally accepted types of dams.

In the old-fashioned timber dams, hundreds of which have been built for logging and power purposes, on all sorts of foundations, it was customary to give the water-tight surface of dams a slope upstream, generally two or more horizontal to one vertical, making a cross-section something like Fig. 1 in the case of an overfall dam. In case the height was considerable, the apron would be divided into two or more steps, to break the fall of the water.

For the purpose of a coffer-dam of moderate height on solid rock or impervious bottom, the same general idea is satisfactory, as shown in Fig. 2. In this diagram the planking is shown laid at slope of one to two. Note the position and direction of the resultant of water pressure. Little theoretical study, as far as the writer knows, has been given to these forms of dams.

It is obvious in each of the above cases that the weight of the water and the back filling have been a large or the entire factor in the stability of the dam, both against sliding and overturning. The beaver, who belongs to the oldest race of dam builders, has always utilized the weight of water for stability, and some of his achievements have been truly remarkable. The lower part of his dams are always open for drainage. The writer contends that his work is more scientific than that of some of our modern builders, as will be demonstrated later.

Now when it comes to the construction of masonry dams, the first ones were probably built entirely by guess, but some of them stood up. A precedent having been established, in course of time, mathematicians came along and found that masonry structures having a factor of safety of two against overturning and of one against sliding on their bases were actually standing up. Therefore a coefficient of friction of 0.6 or 0.7 was assumed, and a sufficient weight of masonry provided to resist the horizontal hydrostatic pressure of the reservoir. Hence we have the standard triangular or trapezoidal section given to solid masonry dams in which the resultant pressure of water and masonry usually falls just inside or at the middle third of the base, so that pressure begins practically at zero at the inner heel and increases to a maximum at the outer toe, provided the structure acts as a unit. The pressure of water and weight of masonry are such that the coefficient of friction is barely sufficient to resist sliding. In fact, if it were not for the dove-tailing into rock at the base of the dam and into the walls of the gorge between which the dams are built, there would

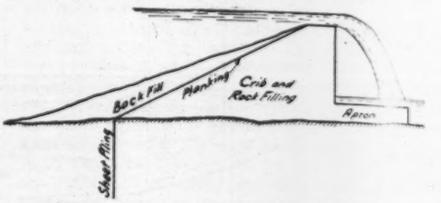


Fig. 1. Cross-Section of Timber Dam.

be many more failures by sliding than there have been. However, so far as mathematics are concerned, we have the astounding fact that in masonry structures of immense importance, and in perhaps no other cases, engineers are content to follow in the rut and build with a factor of safety of *one!* So much for precedent. Further than this, as soon as you assume hydrostatic uplift, or that water enters under the inner heel of your dam, your precious friction coefficient is partially destroyed, and the dam fails. It is only fair to say that most engineers now make some attempt to drain toward the downstream toe of the dam.* Of course, the form of masonry dam is somewhat circumscribed by the fact that no tension is assumed on the upstream face, but the writer nevertheless believes it quite possible to develop a form of masonry dam in which the weight of water and possible back fill is utilized to add stability, and may propose something of that sort in the future.

Fig. 2. Cross-Section of Coffer Dam for Shallow Water.

He surely believes that the ordinarily accepted coefficient of friction as indicated above and the factor of safety of two against overturning, should not be accepted as sufficient.

In earth dams, the writer believes, of course, that the section should be something like that shown in Fig. 3.

The same idea applies to an earth dam, a rock fill dam or like structure with a cut-off planking, reinforced concrete, steel plate, or common puddle. In every case water-tightness should, if possible, be secured as near the water itself as possible, and the vertical components of the hydrostatic pressure should be equal to or exceed the horizontal ones. Western engineers have already followed this idea to some extent in earth and in rock fill dams with planking.

Designers of concrete dams have usually followed the standard masonry profile or something near it. It is human nature, in engineering matters as in other affairs, to follow and develop an established idea, sound

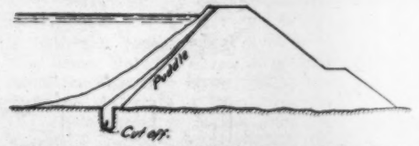


Fig. 3. Typical Cross-Section of Earth Dam.

or unsound, to its utmost limits, while a new one of a very old and forgotten one, must make its way slowly.

Happily, Bainbridge with his steel dam, and Ambursen with his concrete dam, and the idea of the reinforced-concrete retaining wall came along, so that it is now in order to consider a dam having a water-tight face capable of taking tension. Bainbridge's dam consists of a series of inclined bents covered on the upstream side with water-tight concave plates.† In this dam, water pressure is of course taken normal to the water-tight face (Fig. 4). The column loads are taken

*Paper presented to the Western Society of Engineers, June 2, 1909.

†Wisconsin Bridge & Iron Co., Houghton, Mich.

*See transactions of Am. Soc. C. E., Vol. 34, Notes on High Masonry Dams by John D. Van Buren, for argument in favor of a section of masonry dam taking into account hydrostatic uplift.

†See Journal Western Society of Engineers, Vol. X, p. 615.

directly to the rock bottom, and tension of face plates is taken up by anchor rods, as indicated. If not founded on rock, the design must be altered radically, as indicated further on.

Although the Ambursen dam (Fig. 5) utilizes the weight of water to some extent, in my opinion it does not, as ordinarily constructed, provide much greater stability against sliding than the standard profile, though it does thoroughly provide against hydrostatic uplift by the open construction of its base. The main

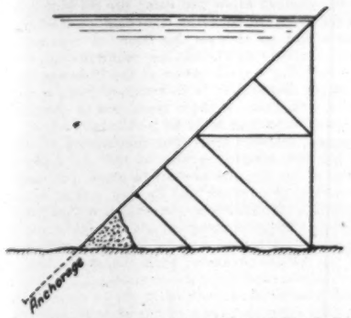


Fig. 4. Cross-Section of Bainbridge Steel Dam.

idea of Ambursen's patent was apparently so to construct the water face of his dam with reference to the cross walls that the direction of water pressure at any point should fall within the base.

Of course, the calculation of stability of a steel dam on rock bottom, with given factors of safety, is very much simpler and more certain than even the design of a steel railroad bridge, and the writer believes that the time is coming when the merits of this construction will be much more appreciated by engineers than is the case at present.

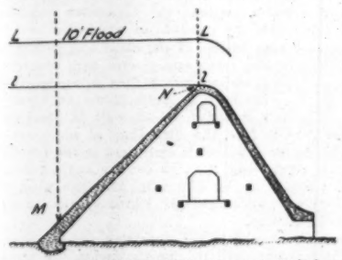


Fig. 5. Cross-Section of Ambursen Reinforced-Concrete Dam.

In designing the cross-section of a steel dam about 100 ft. high, the writer accidentally hit on the idea of making the part near the top, where hydrostatic pressures are light, nearly vertical, and sloping the part near the bottom, where hydrostatic pressures are heavy, until it was nearly horizontal. This resulted in a saving in construction cost, and a greatly increased factor of safety against sliding and overturning.

The idea is illustrated in Figs. 6 and 7, where the plating on the lower section is supported directly in concrete, cheap masonry, or other filling, while the upper part is of steel construction. The amount, position, and direction of resultant pressures depend on the exact shape of the water-tight surface. The vertical water pressure may be made 1.5, 2, or even 3 times the horizontal pressure, depending on the width of base; and the resultant pressure of all, weight of water and structure, may be brought as near the center as desired. In Fig. 6 is shown a dam of considerable height, and in Fig. 7 one of moderate height.

The limits of this idea are shown in Fig. 8. Suppose we have a dam built of a small bent plate: calling the height 24 ins., the base 14 ins., the horizontal water pressure would be 2, applied at 8 ins. from the base; the vertical pressure would be 2.33, applied at 7 ins. from the bend. The resultant would be 3.1, applied practically at the bend. The structure would be just a little more than stable against overturning, and a friction coefficient of 0.86 would be sufficient to prevent its sliding.

In case the base were 24 ins. and the height 24 ins., as in Fig. 9, the horizontal water pressure would be 2 as before, and the vertical pressure would be 4, and the resultant 4, 5 falling at a point one-third of the distance from the bend to the upstream edge of the horizontal plate. This resultant would stand two vertical to one horizontal, giving a coefficient of 0.50 to just prevent sliding. If you prevent leakage at "A" and your plate is stiff enough to prevent bending, you will have, due to water pressure alone, a small dam as safe against overturning and safer against sliding than the standard profile. It is evident, then, that in a dam having a base equal to its height, the sum of all horizontal pressures is exactly that due to the depth of the water, no matter what the shape of the water-tight surface, and it is possible to utilize the vertical pressures from a minimum of zero to a maximum of two times the sum of the horizontal forces, and to bring the resultant of both forces from a horizontal direction to an inclination of two vertical to one horizontal, as shown. Of course, in the practical structure of steel of the Bainbridge type or of concrete, wood, or other material, we would curve the tension face in some manner, and in making our calculation add the weight of the structure itself.

In Fig. 10 is shown the proposed section of a reinforced-concrete dam having a concave water-tight face. Note the position and direction of the resultant of the water pressure and also note that the total resultant falls about half way between the center and the ⅓ point. It is designed to be a very heavy and substantial structure, but contains only about one-half the amount of concrete of that required in a dam of standard cross-section.

In this particular case the water pressure resultant stands at an angle of five vertical to four horizontal, and the total resultant at eleven vertical to five horizontal, and the structure very evidently has some stability against both overturning and sliding. A spillway section employing this principle also works out very favorably in either steel or concrete.

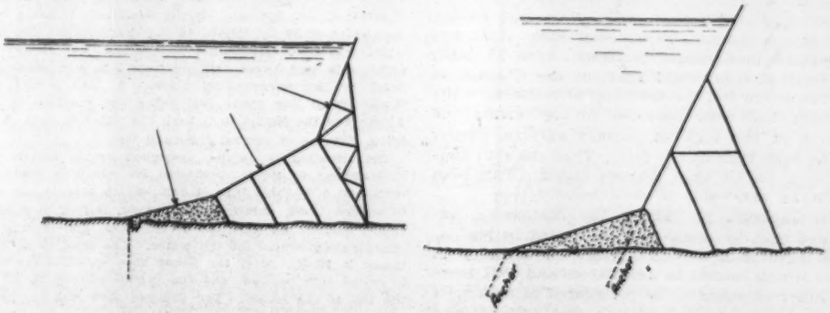
The patent office has recently recognized this principle of using hydrostatic pressure on a concave face to add stability to dams, etc. So far as the writer knows, this is the first recorded recognition of the hydrostatic principle involved. He does know, however, of a mining engineer out West who once built a small concrete dam wrong side to, and with very good results.

The modern inside buttressed reinforced-concrete retaining wall employs a similar idea, but the earth pressures are not hydrostatic. In the earthen dam with masonry core wall, the hydrostatic pressure against the core is of course greatly modified (but nobody knows how much) by the presence of the earth fill on the water side. Its design is eminently a matter of guess work.

In conclusion, my contention is that a factor of one against sliding is not enough, and that we should turn the hydrostatic force to our assistance, instead of working entirely against it. We must have weight to secure stability, and there is nothing for that purpose quite so cheap as the water itself which we are undertaking to confine.

Discussion.

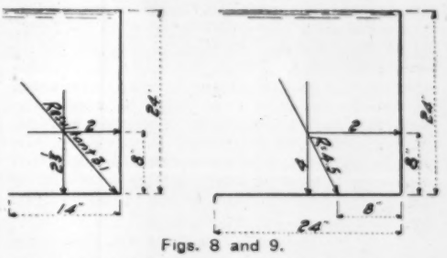
In the discussion, Mr. L. K. Sherman briefly described a small reinforced-concrete dam of special design which will be built by the Sanitary District of Chicago on the north branch of the Chicago River at its connection with the North Shore Canal (to Lake Michigan) now under construction. The river is at a higher elevation than the ordinary water level in the canal, and in order to prevent erosion it was necessary to build a spillway. As the site is on a rather soft clay, a spread foundation was used. An apron was required to prevent erosion by the water, and this was utilized to add to the stability of the structure. This dam, Fig. 11, is 82 ft. long between the abutments or side walls. It is a straight wall, reinforced by triangular buttresses, 12 ft. apart,



FIGS. 6 AND 7. CROSS-SECTION OF SUGGESTED CONCRETE AND STEEL DAMS.

which rest upon the apron. The dam is carried down to a depth of about 8 ft. below the apron, and this part takes up all the horizontal force, without reliance upon friction on the soft clay, which should be considered as zero. The unit pressures are less than 1 ton per sq. ft. The line of sheet piling at the lower end of the dam is put in to check any tendency to erosion or undermining on the canal side. It was not put in to intercept the water, as the lower end would be, of course, the wrong place to attempt this.

This dam has the advantage of being in compression. He thought that Mr. Jackson's proposed dam (Fig. 10) might be open to criticism on the ground that the base is in tension and has a tendency to slide on the bottom. As far as the reduction in the mass of a dam is concerned, he



Figs. 8 and 9.

thought it should be remembered that the mass is valuable as an element of stability. Thus a wall or dam that would be perfectly safe against dead pressure might be damaged by the bumping against it of a canal boat, etc. He did not consider it safe to rely upon friction for the stability of a dam.

A special feature of the specifications for the North Branch dam mentioned above is that they definitely locate all joints and lines of demarka-

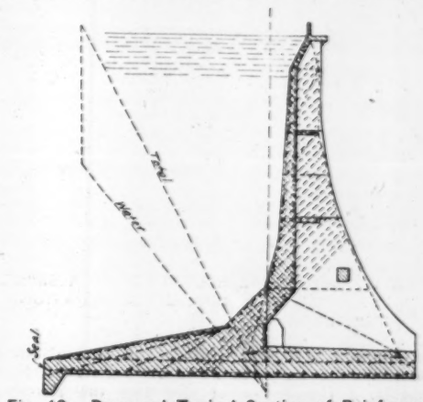


Fig. 10. Proposed Typical Section of Reinforced-Concrete Dam, Suggested by Mr. J. F. Jackson.

tion. Thus both the contractor and the inspector know where work must be stopped and there is no opportunity for dispute as to the way in which the work is to be closed each day. The specifications provide as follows:

No vertical construction joints, lines or surfaces of demarkation in the concrete masonry will be permitted:
(A) In the main wall of the dam excepting opposite the center of the counterforts
(B) In the foundation floor of the dam excepting under the center of the counterforts or excepting in a direction parallel to the crest of the dam
(C) or between the foundation floor and the concrete sills under said floor or in any other part of the work where, in the opinion of the engineer, construction joints or surfaces of demarkation between new and set concrete would weaken the structure. The main wall of the dam shall be built into the abutments without construction joints in the plane of the face of the abutment.

Mr. C. B. Burdick, thought the dam section for shallow water (Fig. 2) mentioned by Mr.

Jackson, has not been confined to cofferdams, but has been used quite frequently especially where a hard bottom is available. It has the disadvantage that the timbers furnishing the strength of the structure are not entirely submerged and are, therefore, liable to decay. As to Mr. Jackson's typical cross section for earth dams (Fig. 3), he believed the location of the puddle core at or near the face to be more nearly correct than the usual location in the middle of the structure. In fact, he thought that in some cases the core might be placed on the outside, serving also as paving, although protection against the action of frost might be a difficulty. With masonry construction, of course, a vertical (or nearly vertical) wall is necessary, but with reinforced-concrete construction this is not necessary, but an inclined concrete core wall or facing may take the place of the inclined puddle core wall shown by Mr. Jackson.

Mr. F. H. Bainbridge thought the dam proposed by Mr. Jackson open to objection in regard to taking care of the ice question. At the Quaker Bridge dam and the Bear Valley dam large forces of men are maintained when necessary to cut away the ice and prevent it from exerting any pressure against the face of the dam. As far as earth dams are concerned, he considered the center of the dam the proper place for the core wall, it being better protected and less liable to slide.

Mr. W. H. Finley agreed with Mr. Burdick as to the desirability of putting the core wall of an earth dam near the face of the dam. If puddle is used, however, it must be protected, as it is not only liable to damage by frost, but is liable also to crack when the water is low and the puddle exposed. He thought the dam should be sealed against water as near the water face as possible, thus avoiding any chance of a saturated mass lying against a central core wall. Mr. Andrews Allen referred to a Colorado dam having a puddle facing on the upstream side. This was illustrated in Engineering News, April 25, 1907.

Mr. I. F. Stern said that on the Chicago & Northwestern Ry. the tendency of retaining walls to slide has been provided for by giving the bottom of the wall an inclined surface, deeper at the back than at the face. Then the wall cannot slide on its base without rising. This plan might be applicable in dam construction.

Mr. Jackson, in closing the discussion, explained that he recognized (as stated in his paper) there is a certain amount of stability in dams which cannot be calculated, and that there are other elements to be considered in making a dam. As far as the relative cost of steel and masonry dams is concerned, he considered that under certain given conditions a dam can be built very much cheaper of steel than of any other material.

THE REPAIR SHIP "CYCLOPS" of the British Navy is a recently constructed vessel of considerable interest. She is a reconstructed merchant steamer, 460 ft. long and 55 ft. broad, fitted up as a floating factory, divided up into workshops of every class, and is equipped with machine tools fit to replace or repair nearly every unit on a battleship.

A Needle Dam on the Pleasanton Reclamation Project, California.*

By JAMES K. JAMES.†

Within the last few months there has been constructed in connection with the Pleasanton Reclamation Project, California, a movable dam, which, though of moderate size, has several points of interest.

The Pleasanton Reclamation Project was organized to undertake the development of the Livermore Valley farm lands of the Alameda Sugar Co. The reclamation of about 5,000 acres has been accomplished by the construction of earth levees and canals to control and carry away the occasional floods. Up till 1906 the entire country thereabouts was partly under water at certain seasons and at all times of a marshy nature; but the efficient canal system now installed has turned it into one of the best drained and most fruitful large farms in the West. The reclaimed land sells at about $250 per acre.

A source of no small annoyance and expense in maintenance developed from the growth of aquatic vegetation in the canals during the summer months when the flow was small. To provide a remedy for this trouble it was proposed in 1907 to build a dam across the main line drainage canal in order that the water may be kept sufficiently deep in all parts of the channel during the dry season to completely drown out the vegetation. Incidentally, it was in recognition of the importance of creating a means by which the summer flow might be utilized, by allowing it to accumulate for such periods as would be necessary to collect a body of water large enough to be used advantageously for irrigation purposes. The new facilities provide for a storage supply of over 150 acre-ft., which is held in the canal basins and may be drawn upon as occasion demands.

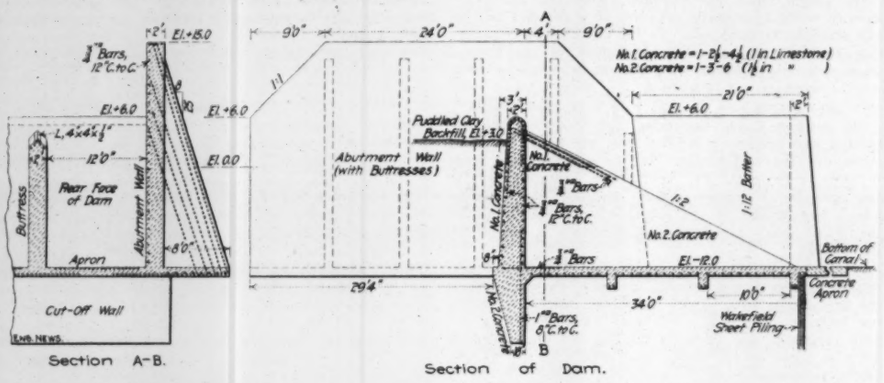


FIG. 11. SECTIONAL ELEVATION OF A SMALL REINFORCED-CONCRETE DAM WITH BUTTRESSES AND SPREAD FOUNDATIONS; NORTH BRANCH CANAL (CHICAGO SANITARY DISTRICT.)

To comprehend clearly the significance of the particular design and construction adopted for this dam it will be best to consider briefly the works to which it has been added.

The canal works include seven miles of main line and five miles of tributaries. The drainage area supplying the canals is about 200 square miles, and the fluctuation between the dry and wet season flow is considerable. The main channel is designed to carry a maximum flow of 5,000 cu. ft. per sec. Briefly described, it has a bottom width of 34 ft.; depth, 12 ft.; grade, 1/8%. The material excavated during its construction was thrown to either side, and levees built up from 7 to 8 ft. above the level of the surrounding fields. A dam across the Mocho—main line canal—just below the junction of the Alamo and the Mocho, will back the water in each canal for a distance of several thousand feet.

The situation is unique, inasmuch as the canals are still subject to floods, provision for which is made by designing a movable type of dam, which may be, in case of sudden flood, immediately released, falling to a horizontal position on the floor of the canal and leaving an unobstructed course for the water. The head to be sustained is 16 ft. After the floods have subsided the dam is raised into position and the canals allowed to fill to the top of the levees. The summer flow was increased by boring 12 artesian wells and leading them by underground tiles into the canals above the dam. By using a movable pumping plant (traction engines and 15-in. centrifugal pumps moved along the roads on the canal levees) it will be possible to irrigate the entire 5,000 acres. Gates inserted in the levees will also permit of gravity application at certain points. Any variation in the summer flow may be regulated at the dam through a gate valve located in the walls, and by flash boards.

*Arranged from the California Journal of Technology, February, 1909.

†Assistant Engineer, Pleasanton Reclamation Project, Pleasanton, Cal.

In choosing a type of movable dam the following conditions were considered: (1) A head of water 16 ft. must be sustained; (2) Maneuvering in case of sudden and unexpected rises in the stream must be safe and easy; (3) The dam should be maneuvered by the aid of the natural forces of the water course; (4) It should be sufficiently tight; (5) It should be composed of strong parts; (6) It should afford no obstacle when exposed to the passage of floods; (7) It should be economical in regard to cost and operation; (8) Scour should be guarded against below the dam; (9) No difficulty should be anticipated in lowering the dam on account of deposits of silt or sand on the floor. A type of dam was finally evolved answering the requirements and which was essentially a combination of the Chanoine wicket and the Poiree needle. It is in many respects a radical departure from dams of those types now in operation. The high head sustained is to be particularly noted. Among the salient features are: The substitution of steel channels for the wooden needles of the old type; the new method of holding the needles in place; the relative ease in lowering and raising and the low cost of construction.

SUBSTRUCTURE.—The foundation of the Needle dam consists of concrete masonry and embedded and attached metalwork. Broadly speaking this work may be divided into (1) the abutments at each end of the dam, and (2) the foundation between the abutments.

Each abutment consists of 30 ft. of concrete retaining wall. These walls have a height of 16 ft. and are carried up in two steps with horizontal offsets of 6 and 4 ft., respectively. By stepping in the walls in this manner the canal section was closely adhered to. The change in section at the dam is therefore small and scour to the canal banks due to this cause is reduced to a minimum. Both the vertical and horizontal portions of the abutments are laid with 12 ins. of concrete and reinforced with ¾-in. round rods, 12 ins. c. to c., which run continuous from top to bottom. The ends of the abutment walls turn into the bank at right angles with the direction of flow, and are carried back into the natural material to cut off water which might filter through the earth behind the abutments.

The foundation between the abutments consists of a 12-in. floor slab, the concrete in which was laid directly on the hard clay bottom of the canal and reinforced both longitudinally and transversely with bars spaced 12 ins. c. to c. Along the upstream face a prismoid of concrete 4½ ft. wide by 5 ft. deep, forms an upper cut-off wall. Similarly a lower cut-off wall is provided along the downstream face, the dimensions of which are 1½ × 6 ft. This latter prismoid is embedded in the tops of 8 × 8 in. piles, 20 ft. long, 2 ft. on centers and extending in a row the length of the dam (Fig. 2). The wing walls of the abutments were carefully joined by the cut-off walls of the foundation.

The concrete used in the floor slab and cut-off walls is a 1:2:4 mixture, and in the abutments the proportions are 1:3:6; Portland cement, Monterey sand and screened crushed limestone that passes a 2-in. ring. The mixing was done by hand.

FOUNDATION METALWORK.—Upon the top of the floor slab, and built as a part of it, is a 3 × 36-in. sill. This sill extends the length of the dam along a line at about the two-third point from the upper toe. A 1½-in. round iron rod traverses the center of the sill, and besides being embedded in the concrete of the latter, is securely anchored at intervals of 12 ins. by stringing on pipe T's into which tie pipes are screwed and bent down into the foundation masonry. This is indicated in Fig. 3.

Of the two vertical units of the dam proper, one, that on the downstream side, called the tripping device, is composed of 15-ft., 10-in. length of extra heavy 2-in. pipe, which is provided at one end with a journal box enveloping the rod in the sill. These journal boxes of the tripping device are also pivoted on 12-in. centers along the rod and spaced midway between the anchors. The journals are essentially 2 × 2½-in. pipe T's, the body of which is strung about the rod, and into the collar is securely screwed the tripping pipe. To enable the journals and attached pipe to describe a quadrant about the rod as an axis and to allow the pipe to assume a horizontal position on the downstream floor when the dam is lowered, the sill has been slotted on the downstream face. These slots, moreover, serve as a guide to prevent adjoining pipes from fouling one another when falling to the floor (Fig. 3). That portion of the sill which is upstream from the rod, however, is made of solid section, for upon its face will rest the superstructure.

IRON ANCHOR RODS.—½-in. anchor rods, 12 ins. c. to c., are built 6 ft. onto the masonry of the upper cut-off wall and extend in a line the length of the dam. The upper ends of these rods terminate in eyes which project 2 ins. above the floor (Fig. 2). Through the eyes an iron bar is strung, the purpose of which is to serve as a support and pivot for the inclined tension rods, forming a part of the superstructure, which will be described later.

CONCRETE BY-PASS.—In order to regulate the flow when the dam is raised a concrete by-pass has been provided. The intake is in the abutment wall at the floor

level and upstream from the line of needles. The passageway is 24 ins. square and is operated by a 12-in. standard low-pressure iron water gate, whose flanges are embedded in the concrete of the pass. The outlet is similarly situated in the abutment wall, only at a point downstream from the line of needles (Fig. 1).

Fir poles have been embedded in the concrete of the abutments, one on each side and located slightly downstream from the line of needles. The tops of these poles are provided with iron hooks between which a cableway may be strung (Fig. 1).

SUPERSTRUCTURE.—The movable dam proper is secured to the foundation thus prepared. A unit of this needle dam consists of the following parts (Fig. 3):

A needle which is a 10-in., 15-lb. steel channel, 15 ft. 11 ins. in length. Riveted to the outside of the web at one extremity is the 3-in. leg of a 5 × 3 × ¾-in. standard angle iron. These angle irons are cut the width of the channel and so fitted to the latter that the back of the projecting leg is flush with the end of the channel. A 3-in. semi-circular seat is scalloped out of the 5-in. projecting leg as shown by Fig. 8. Two-thirds of the height of the needle from the angle iron is fastened a standard U-bolt, into which fits the eye of a ¾-in. round tie rod. The head of the U-bolt projects from the inside of the channel web, between the flanges. Each tie is composed of two 9-ft., 10-in. lengths joined by means of a turnbuckle to allow any adjustment in length. The two free ends terminate in eyes, one of which fits into the U-bolt on the channel. The other eye is pivoted about the horizontal bar which traverses the floor of the dam on a line above the upper cut-off wall.

When the channel is raised the U-bolt forms the axis of rotation for the eye of the tie rod. The tie assumes an angle of about 45° as the channel becomes vertical. At this point the long 2-in. pipe of the tripping device is revolved about its axis and also swung up to a vertical position. The bottom of the channel is forced slightly downstream by the water pressure until the semi-circular seat arranged on the projecting angle leg engages about the journal box at the foot of the tripping pipe. The pipe and the channel are the same length, so when both are vertical the tops coincide and may be fastened together by a hook (Fig. 2). The channels are thus supported at the bottom by resting on the sill and bearing against the journal boxes of the tripping device.

At the top they are held by the inclined tie rods. When the dam is filled with water the needles and tripping pipe have a slight downstream batter; so to lower the dam it is only necessary to remove the hook joining the top of the needle with the top of the pipe to cause the latter to overturn and swing into its respective slot in the floor slab. The needle now has no support against the water pressure at the sill and the bottom slides downstream till the whole needle finally falls into position on the floor. The needles when down lie below or downstream from the sill; therefore are protected by it. The sill, in turn, is as low as the canal bottom above and below the dam; hence offers no obstruction to the flow of water.

The dam is formed by a series of these needles, extending across the canal, each unit being independent of its neighbor. The needles are 10 ins. wide and spaced 12 ins. on centers, leaving a 2-in. space between adjacent members. This prevents needles hitting one another during maneuvers. V-shaped calking timbers may be inserted in these spaces to make the dam watertight.

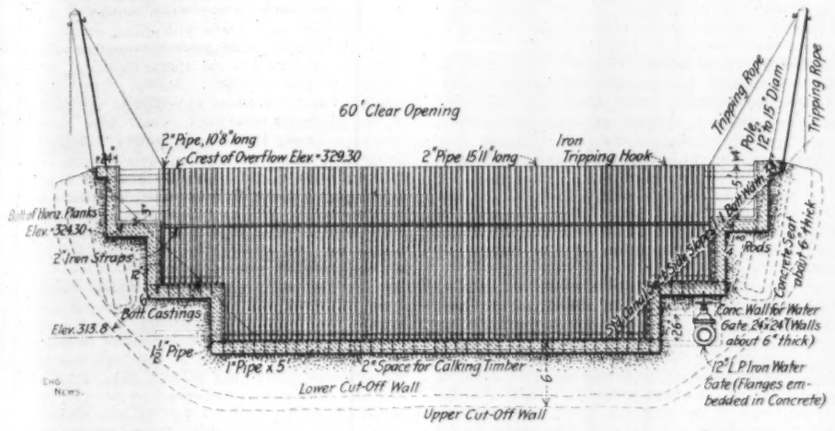


FIG. 1. DOWNSTREAM ELEVATION OF NEEDLE DAM, PLEASANTON, CAL.

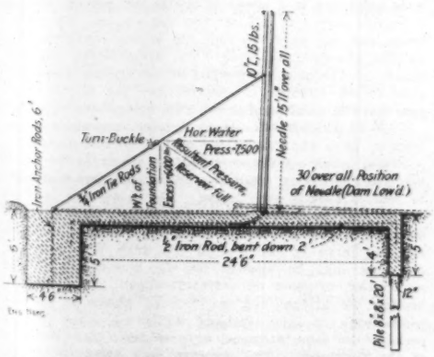


Fig. 2. Cross-Section Through Middle of Dam.

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Between the two poles projecting upwards from the abutments a cableway is stretched. By means of a trolley the hoisting sheave is then shifted across the cableway to a position above the needle to be raised. Over the sheave passes a chain having a hook at its free end. At the top of each needle is a handle. By placing the chain hook in this handle and pulling on the free end of the chain the needle is raised from the floor. After being raised nearly into position, it is left suspended. By a similar arrangement the tripping pipe is raised, caution being exercised to engage it into the semi-circular seat in the angle iron at the bottom of the needle. The pipe is then close up to the needle and the two hooked together at the top. This operation is repeated till the 52 needles composing the dam are all raised.

The upstream arm of each tripping hook is extended several inches beyond the flanges of the channels and the projecting arm bent with a lip. A timber float is run transversely the length of the dam, directly under the lips of the tripping hooks. The buoyancy of the water will always keep the float at its surface and it is so arranged that when the water reaches nearly to the top of the dam the floats lift the hooks sufficiently to disengage the tripping pipes and the channels. The pipes then swing downstream and are followed by the needles.

The experience thus far gained with this dam indicates that its operation will be speedy and sure, although it has not as yet had sufficient trial to demonstrate how it will behave under all conditions or what unthought-of difficulties may arise.

Under favorable conditions a dam of this type may be erected for $100 per lineal foot of dam.

Attention is called to the advantageous distribution of stresses in this special design. Considering the dam as a whole the calculations show that the lines of resultant pressure lie within the center third of the profile.

The dam was designed by Messrs. F. H. Tibbetts and P. A. Haviland engineers in charge of the Pleasanton Reclamation Project. The erection was done under the supervision of Mr. Tibbetts, who was represented in the field by the writer. The officers of the Alameda Sugar Co. are: John L. Howard, President; E. C. Burr, Vice-President and General Manager. The contractor for the foundation and embedded metal work was the E. B. and A. L. Stone Co., Elmhurst, Cal., of which Mr. D. U. Teffelmeir is superintendent.

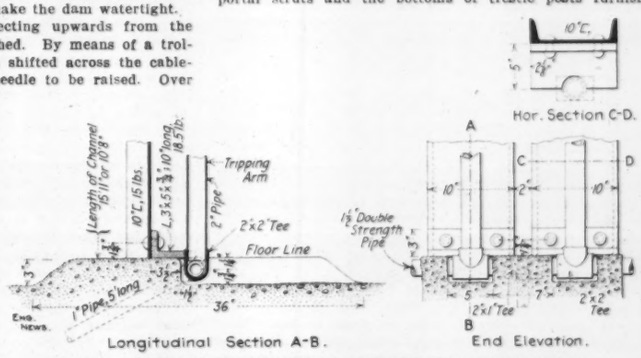

FIG. 3. DETAILS OF TRIPPING DEVICE ON PLEASANTON NEEDLE DAM.

Stray Thoughts on Bridge Design and Maintenance.*

By HERBERT C. KEITH,† M. Am. Soc. C. E.

The Anti-Tuberculosis League issues circulars with the alliterative truism that "dirt, dampness and decay promote disease." Similarly the engineer should constantly remember that dirt and dampness are also conducive to the destruction of his bridges. Of course we all know this; and we also know that the rule applies not only to wood, but also to iron and steel. Yet how unusual it is for proper precautions to be taken to prevent the collection of dirt upon our structures.

TIMBER FLOOR DETAILS.—For instance, we often see stringers of I-beams or channels for the trolley tracks on a highway bridge with timber stringers only a half or quarter inch away for the planking. Thus a pocket is formed where dust and street filth will collect and hold the moisture, both to corrode the steel and to rot the wood. Why not set the timber two or three inches away? The apparent reason seems to be the saving of a few inches of shelf angles:—dollars sacrificed to save pennies.

Another common practice is the placing of the floor only 1 or 2 ins. from the top of floorbeams; in such a case, unless some preventive is used, dust will collect on the floorbeam flange, while with a space of 6 or 8 ins. the breeze would keep the top of the beam clear. Sometimes even a small strip of wood is laid on top of the floorbeam, entirely preventing all possibility of the wind passing through, as if it were considered too much to ask of the planking that it should span a gap the width of the floorbeam flange. A still worse modification of this evil is where the under planking is laid with its top from ¼-in. to 2 ins. above the top of the floorbeam, perhaps to provide a slight crown in the street surface, and a pocket left under the top planking with no outlet whatever. A restricted depth for the structure may suggest such construction, but if the floor must be laid so close to the floorbeam, the space may be filled in with asphalt or similar material, or at least a thick coating may be used to protect the steel.

OTHER CASES OF POOR DRAINAGE.—Truss chords, portal struts and the bottoms of trestle posts furnish other common examples of pockets for the collection of dirt and its usual accompaniment of moisture; effect must follow if cause is present. Trough sections for chords should be avoided, and portal struts and similar members should as far as practicable be made so as to *shed* water rather than collect it. When a trough form is necessary, large holes should be drilled through the bottom to provide drainage; small holes get stopped with paint or dirt. Pockets in bases of posts should be filled with rich concrete (not less than 1-2-4 or equivalent with gravel) put in very wet and the top finished with neat cement and the surface smoothed to drain properly.

Parapets of insufficient length or height may allow the fill to run over on bridge seats and around the steel or wood.

For the sake of a neater finish, the planking of roadway and sidewalks is generally made to fit nicely against webs and around stiffeners or girders. Original neatness is soon lost by the blistering of the paint, and later rust flakes under those blisters tend to the destruction of the bridge. It is desirable to leave a 2 or 3-in. air space next to girders if practicable. For bridges over steam railroads this might be objectionable, because of smoke and steam that would come through; in such case a beveled strip may be used to throw the dirt away from the girder.

The writer has many times had to break away mortar laid up around a timber sill resting on a concrete or stone pier. Someone with good intentions had tried to

*Extracts from a paper read before the Connecticut Society of Civil Engineers, February, 1909.

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protect the timber, with the actual result of holding the water around the timber until serious damage was done.

Timber stringers are sometimes laid with their ends surrounded by the fill, or with insufficient parapet to keep back the earth; in such cases decay follows very rapidly, for capillary action will draw the moisture along the grain of the wood much farther and more seriously than it can enter across the grain. It is sometimes well to smear the ends of timbers with tar or pitch. Spike-holes should be plugged, and the bark removed from piling. Except where teredo or limnoria are factors affecting their life, piling and timber posts decay far more rapidly near the top of the ground or the surface of water than either above or below this region.

In recent construction it is not often that two timbers are laid side by side close together, but frequently too little space is left between. It should never be less than an inch, and 2 ins. is preferable; a pebble or straw may start the collection of dirt and the space become filled. Similar trouble may be found where two eyebars in a steel pin-connected truss bridge are laid close at one end and spread apart at the other. Either they should be laid close for the whole length (which is undesirable if it can be avoided), or spaced open for the whole length. If a V is formed, dirt is sure to collect and corrosion to follow.

It is also desirable to avoid contact of timber surfaces wherever possible. In timber trestles stringers are sometimes spaced by use of wood packing-blocks. Such stringers may be seen rotten for thicknesses of 2 ins. each side of such packing-blocks and extending several inches longitudinally beyond the length of blocking, while elsewhere the timber is sound. The use of cast-iron separators would avoid this danger.

CAST-IRON SHIMS IN TRESTLES.—The durability of timber trestles is sometimes greatly increased by the use of cast shims between the posts and the sills and caps, and on caps under stringers. Due care should be used in designing such construction lest other and greater troubles follow as a result. The tops of timber stringers are generally first to decay, because of moisture held between stringers and planking; a coat of tar or similar material, or even of paint, may add greatly to the life of both stringer and planking.

In double planking, unless the lower layer is creosoted or treated with other preservative, it will rot rapidly; in highway bridges the top layer is likely to wear out.

Railroad bridges have been known to be planked for the express purpose of protecting the ties from the weather. Ordinary weather will be far more merciful to ties than the moisture that is sure to soak through the plank or between them and dry out only slowly. Of course a pitchy timber will keep out the moisture much better than more porous woods.

Perhaps it may not be amiss here to call attention to the fact that all woods suffer great reduction of strength before they reach such a condition as to be called rotten. Oak and chestnut suffer in this way, while still apparently retaining their original texture.

It is well known that cement, being alkaline, acts as a preservative for iron and steel; and, probably with this in mind, the ends of I-beam stringers are sometimes encased in abutments, perhaps composed of sandstone laid with a very thin mortar. The porosity of such masonry will do more harm than to balance the alkali of the cement. But even in rich concrete, temperature changes will loosen the stringer in the masonry, unless the span is very short, and corrosion will result. In a certain very short stringer span now in mind, where the concrete is still sound, there is another trouble never elsewhere observed by the writer in anything like the same degree, though a suggestion of the same trouble has been observed; there is a decided reduction of section by rust on the whole periphery of the beam due to rain flowing down the face of the abutment.

PAINT.—The value of paint does not seem to be perfectly understood by all men having the care of bridges, for sometimes it is used on timber where it would be better for the structure not to be painted. When ties on a railroad bridge are painted, the top is soon worn through, allowing the moisture to enter the tie, while the paint on the bottom, sides and ends prevents its quickly drying out.

As many of us know, it is hard to get painters to thoroughly clean off dirt and rust—in fact, it is often said to be impossible—but if metal is not cleaned, paint is worse than wasted that is put on over rust (unless the spots are small). If the skin of paint is broken, moisture will be held against the steel the longer to do its destructive work.

We sometimes hear a large thickness given as the amount of paint on a bridge, because the calipered thickness of a member exceeds that given on the plans by the stated amount. It is not safe to jump too hastily to such a conclusion, for the fact may be that there is but little if any sound metal left. Rust swells to from three to eight times the thickness of the original metal of which it is composed; a little experience will enable one to judge, by the appearance of the rust flake, approximately what thickness of metal it represents.

IRON VS. STEEL.—While on the subject of rust it may not be improper to speak of the great superiority of iron to steel in this regard; the writer believes that if it were possible to obtain structural iron such as was used 25 years ago, we could well afford to pay double the price of steel, in spite of the fact that steel has the higher ultimate tensile and compressive strength. If both were cared for according to our ideals, both iron and steel would have a durability almost inconceivable; but—alas for human frailty!—even men trained in just this line all their lives have allowed their own property to be neglected. If such men allow their own pockets to suffer so, how much more are bridges in care of untrained officials likely to deteriorate, especially in the hidden parts? With ordinary care—or neglect—good, well-puddled iron has a life several times as long as that of ordinary commercial structural steel.

A bridge is in mind where, in order to strengthen the floor, steel stringers were added ten years ago to reinforce the iron stringers, then about ten years old. These steel stringers showing serious depreciation—or perhaps to further strengthen the floor—additional steel stringers were put in a few years later. The older steel stringers have little more than a rust streak left and the newer ones are in a much worse condition than the original iron stringers placed there four times as long ago. Of course it will be observed that this bridge is an unusually bad illustration of how bridges are neglected.

CAST IRON TO SHOES.—In this connection may we not ask why cast-iron pedestals should not be more frequently used for a girder or truss instead of shoes built up of plates and shapes? Cast-iron will stand far more neglect than rolled or forged metal—either steel or iron. Such pedestals may require more metal to give equal strength, but dirt is sure to collect on bridge seats, especially if the ends are closed, and it is desirable to keep the more vulnerable rolled metal up out of danger. Of course in many places cast shoes would be out of the question. At times low bearing blocks of stone set above the general bridge seat would be a happy solution.

ROLLER BEARINGS.—In the United States there are thousands of bridges which have roller bearings in which the diameter of the rolls is from 1¾ to 3 ins., and in which the rolls have not turned for years. In fact, it is doubtful whether there are as many hundreds of roller bearings of less than 3 ins. diameter which work as they were planned to do, as there are thousands with the bridge sliding upon the rollers. A small amount of dirt collects under the rolls, so that the sliding friction on top of the rolls is less than the force required to turn the rolls over the dirt. Or perhaps, instead of extraneous dirt, the obstruction is a thin film of rust on the bedplate, swelling and presenting an obstruction more firm than would be made by any dust the breeze would be likely to carry. At a certain highway bridge in one of the large cities of this state, the roller bedplate shows such a layer of rust nearly ¼-in. in height (representing about 1/16-in. of original metal). Large segmental rollers should be used instead of the smaller sizes of cylindrical ones.

CONCRETE.—Though many enthusiasts seem to consider concrete an ideal construction material in every way, especially when used in combination with steel, yet some more conservative (even if the propriety of calling them more careful be denied) engineers, see danger in its unrestricted use in all places, at all times and under all conditions. Probably it will be generally conceded that concrete is sometimes poorly mixed or placed, and that the resulting structure is unsatisfactory. It may also be acknowledged that when concrete (especially if lean and mixed rather dry) stands in tidal water and is subjected to freezing weather between periods of submersion, it is liable to disintegrate to a greater or less extent. A case is in mind where concrete which presents a good appearance above high-water mark has lost a large part of its surface below that level, with a maximum depth of hole of nearly 2 ft. from the face of the masonry; this wall was built only seven years ago. Had this been the face of a reinforced-concrete arch, the condition of the reinforcement may be imagined. The writer is of the opinion also that sea water filled with sewage and acids from factories and dyehouses might cause disintegration of concrete, even if the temperature never fell to the freezing point.

Perhaps, too, even the enthusiasts will admit that some reinforced concrete is designed by incompetent engineers, or by men with more confidence than engineering training or ability. Attention might be called to a reinforced-concrete arch footbridge which was probably beautiful to look upon when it was built, with its marble tablets telling the name of the donor, but now its contours suggest the convolutions of a snake. It is to be hoped that its collapse will not occur when loaded to what was claimed as its capacity.

The writer has great respect for good concrete, both plain and reinforced, for well-designed structures, built in suitable locations and of materials well mixed and of good proportions; but in view of the large amount of reinforced concrete built where one or more of these conditions is not fulfilled, he believes that 15 or 20 years hence reinforced concrete will be less popular than at present. He does not mean to say that the expected disfavor will be more reasonable than the present popularity.

FOUNDATIONS.—Bridge substructures are generally considered such simple things, and are generally built of such durable materials that there is but little study given to them, unless there are unusual features connected with them, such as unusual size or occasion for artistic development. It is surprising to see how many abutments and piers are built right on the bed of the river, or the top of the ground, or nearly so, with no thought of settlement, or possible scour from the current, or heaving from the frost. Some are too thin for their quality, while others waste enough to make up; again, we see some plans with piling standing unsupported for a great depth below the platform, simply because its slimness was not appreciated as it was under water and out of sight. Riprap, either dumped in loosely or carefully placed according to the requirements of the particular conditions, would have saved many structures from failure. In waters infested by the teredo and limnoria, however, unless riprap could be depended upon to silt up quickly and stay filled (which can be expected only in rare cases), the pileheads should be protected as well as stiffened by concrete. On the other hand, a short time ago, in the case of a certain bridge and its substructure, in water far from the sea and therefore without danger from these borers, the fact that the concrete about the pileheads was poor was urged to belittle the value of the property, and it was claimed that expensive cofferdams must be built and the old concrete removed and replaced with new; the only value of the concrete in this case was to stiffen the pileheads, which was as well done by the existing concrete, poor as it was found to be. If there was danger of the old concrete washing out (which was not shown), the use of a little riprap would have saved thousands of dollars of what was proposed to be spent. Or in the original construction there might have been a saving by the use of riprap instead of concrete.

Perhaps it will be considered a digression, or a change of subject, but there are a few points in general design of which the writer would like to speak.

JOINTS.—A large proportion of our bridges, even of modern build, are limited as to their capacity by "skimping" on the details. A few days ago a bridge was examined that had failed under load, the bottom chord of the truss having broken off square just because its real strength was only about half what might have been supposed from an outline drawing giving the sizes of the main members. The reinforcement for the middle panel stopped so close to the panel point that its strength could not be developed, and in the attempt to do so in a short distance, rivets were so crowded that the net section was greatly reduced.

Three thousand years ago the much-quoted wise man said, "Put not your trust in princes." Had the psalmist lived at the present time and had as large experience at bridge inspection as he did with royal families, he might now say, "Put not your trust in faced joints." To be sure, to err on the side of moderation rather than of exaggeration, it may be safely said that in light highway bridges not one case in ten, where the plans call for faced joints, has a satisfactory joint in the finished structure. Were it not for the fact that the efficiency of rivets is far in excess of what our ordinary working rules suggest, many bridges now doing good work would long ago have gone to their destruction.

Apropos of rivet and pin values; a bridge was taken down about 20 years ago in which, according to the ordinary rules for figuring them, certain floorbeam rivets were subjected to a shear of 80,000 lbs. per sq. in. and a bearing stress of 130,000 lbs. per sq. in. The floorbeam was cut apart to find the actual conditions and nothing abnormal appeared. The same bridge had pins which, by the common method of calculation, would appear to be strained to 300,000 lbs. per sq. in. The pins were in good condition. This bridge was of iron.

END FLOORBEAMS.—Many bridges, especially drawbridges, have end floorbeams of wholly inadequate proportions, because made only half as strong as the intermediate floorbeams, while the actual load they may have to bear is usually even larger. Let us suppose the case of an end floorbeam of a drawbridge; the stringers must be carried across the beam and overhang, to allow for the curve of the end of the draw plus whatever clearance may be allowed for the trusses. A car or road-roller, or even an ordinary wagon, in entering or leaving the bridge, has one pair of wheels at the extreme edge of this overhang while the other pair is perhaps the same distance, or even less, the other side of the floorbeam. The leverage may bring the whole weight (or possibly more) of the car or other vehicle upon the end floorbeam; while with an intermediate floorbeam, unless the panels are long, it is impossible to get as great a load. To the further disadvantage of the end floorbeam, the vehicle in coming upon the draw span has to cross an opening of greater or less width, and strikes the edge of the overhanging floor a blow that must awe any engineer observing it and remove any surprise he may have had at seeing the condition of the floorbeam beneath.

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The popular fallacy that the pressure on a reservoir dam increases with the length of the reservoir or the area and volume of water impounded by it has had many fresh illustrations of late in the form of press despatches voicing fear that the great Pathfinder Dam, recently built on the North Platte River, Wyoming, by the U. S. Reclamation Service will be swept away by the high water which has been so prevalent of late in Western rivers. Thus after noting apprehensions of failure a press despatch dated June 30 says:

> The danger can be appreciated when it is realized that the 215-ft. dam backs up the North Platte River for twenty miles and the Sweetwater River for fifteen miles. The reservoir is four miles in width and covers an area of about 25,000 acres.
> Within the last week fifty men have been sent from Denver to assist in the work of strengthening the dam, the request for additional help coming direct from the resident government engineer, Ira McConnoll.

We may explain here that the "strengthening" referred to had nothing to do with the main dam but was directed to a dike built across a low place in the valley some distance away from the main dam. This dike had not fully settled when the high water came against it and means were taken to prevent the pressure against it reaching a point that might have caused a breach.

With a pride that certainly can be pardoned, the Mayor of the city of Galveston and his associates sent out after the serious storm of July 21 the following message:

> The city of Galveston sends greetings to her sister cities, the people of the United States and of the world, in that at this hour it has just passed through a most formidable storm, manifesting in its course some of the most violent incidents and cyclonic disturbances, and its great sea-wall has completely vindicated its efficiency and protected the city against dangers from the sea, leaving such insignificant damages as are incident to all storms. The city, its great business interests and its people have safely passed through a most severe hurricane. The sea-wall proved a complete success, and the city's great wharves and shipping interests suffered no damage.

On Sept. 8, 1900, a hurricane of unprecedented fury swept up the Gulf of Mexico and drove the waters of Galveston Bay ten feet deep over the wind-torn town, drowned or otherwise killed some 6,000 people and destroyed property to the amount of many millions. For a time the abandonment of the town-site was discussed, but the magnificent port was too good to lose and the citizens appropriated enough money to build around the city a huge concrete sea-wall, behind which hydraulic dredges pumped enough earth to raise the city level above the height of the 1900 water, a height caused by most uncommon meteorological conditions. Aided by the federal government jetties this wall was expected to prevent the recurrence of the previous catastrophe, and the city started again toward that growth that has made it the second port in the country.

The storm of last week was one of the occasions for which the improvements of 1905 were made. Although not equaling in its fury the destructive hurricane of 1900, it still was of such intensity that the city would undoubtedly have been destroyed without the protection of the wall and the raised level. Such damage as was done was the result of winds, common to every town under like conditions, or to overflow of those portions which have not yet been brought to the raised level.

If ever a community were indebted to the engineering profession, Galveston would seem to be the one, and we are glad to record in the extract above the acknowledgment of this indebtedness, if not to the profession, at least to the works which are the fruits by which the profession is known.

It is often said that city government in the United States is a failure by reason of political corruption and consequent inefficiency and dishonesty. When one studies the workings of local government in the rural districts, however, one is led to question whether there is not quite as much inefficiency and loss to the taxpayers in the use of public funds in the rural districts as in the cities. Very likely, actual dishonesty may be less prevalent, since in the rural districts people are much better acquainted with each other. On the other hand, there are greater difficulties in supervision of public work, so that the net loss to the taxpayer may work out quite as high in the country as in the city.

We are led to these reflections by the perusal of a paper published elsewhere in this issue, describing the experience of Missouri in the operation of a law which was framed with the excellent intention of placing the maintenance of highways in the state under engineering supervision.

Many and many a time has it been urged that if only competent engineers were given the task of building and maintaining highways there would be an end to inefficiency and waste. The Missouri Legislature passed a law providing for county road engineers. On its face it appeared to have excellent features; but the county boards, to whom the appointment of county engineers was entrusted, appear to have in many cases treated the office as a political plum, and only in exceptional cases does it appear that good results have been obtained.

We venture to raise some questions suggested by this Missouri experience. In how many rural counties of Missouri or any other state are competent highway engineers to be found? Is a competent highway engineer needed to supervise the repair of ordinary rural highways, and if needed what proportion of the scanty funds devoted to road mending should be diverted from the labor account to pay for engineering services? Or would a competent highway engineer for each county, if given ample authority, save his salary and something more each year, directly by preventing wasteful methods of repair and indirectly by better roads?

Of course, where a large mileage of macadam roads is to be built, as is being done in New York, Pennsylvania, Massachusetts and some other Eastern states, the employment of competent engineers is absolutely essential to good work.

We are speaking now, however, of the ordinary repair and maintenance of dirt roads. Certainly, before attempting the large task of placing competent local highway engineers in charge of earth road repairs, it would be well to try the plan, already working with fair success in a number of states, of appointing a state highway engineer. Such an officer can work with and through the existing local road authorities. As the work develops he can train or select assistant or district engineers to supervise the work in different parts of the state; or these may be appointed at the outset, where conditions warrant such a course. In almost any state, a state highway engineer can do valuable work, not alone in aiding toward good practice in highway maintenance and repair proper, but in the design and construction of highway bridges.

New York City may justly feel thankful at having escaped the imposition of a new building ordinance, after a hot fight against its passage. The Board of Aldermen gave little heed to the protests, but the Mayor vetoed the ordinance, and until after the coming municipal election, at least, the city need not apprehend its resurrection.

Other cities may also take pleasure in the defeat of this ordinance. Past experience shows that the building laws of New York City are often taken as a model elsewhere, and are referred to as a reliable and authoritative guide on good construction. It is quite certain that the defeated ordinance would have been a sorely disappointing guide, and a deplorable model.

This proposed ordinance, intended to replace the existing Code (written about ten years ago), was not unsatisfactory as a whole—if we except a few minor faults of omission or commission—but it contained a number of most vicious provisions or restrictions wherein certain special interests were given advantage. Because of this, various building contractors, architects, engineers and others made a determined and intelligent fight against it.

We have already printed some of the protest arguments, which fairly reflect the motives of the objection. To bring the matter concretely to mind, we may note that in its original draft the ordinance discriminated against natural cement, specified a proprietary paint for structural steel, required the installation of an almost unknown proprietary type of fire-service stand-pipe in old and new buildings, fixed dangerously high limits for the size of unbroken floor areas, and, worst of all, discriminated against both structural and fireproofing concrete to a fatal extent.

A few of these objectionable features were eliminated before the Aldermen passed the measure, because of very strong public protests. But the discrimination against concrete, to the enormous advantage of brick and tile fireproofing, was left in, and thus the measure was passed—by a vote of 40 to 38. The Mayor, fully informed of the vehement opposition to the proposed law, held further public hearings, and soon learned enough to decide him to veto it.

But the pleasure of being saved from this law is alloyed with one or two less pleasant reflections. In the first place, the business of modernizing its building law is proving a sore expense to New York City. Some $200,000 has been spent on the diversion during the past three years, in two attempts, both unsuccessful. The first one, two years ago, produced a fairly satisfactory ordinance, which was then thrown into the waste-basket through political chicanery. The recent one was lost through its own sins. So far, then, there is nothing to show for the great sum spent by the two "expert" commissions. Future attempts will probably involve additional expense of like proportions, and it is not impossible that they too may encounter pitfalls of one kind or another that will make the results worthless.

Again, the commendable and successful fight against the plainly vicious sections of the proposed ordinance was mixed up with a great deal of unworthy opposition. The drafted ordinance was, as we have said, a very creditable document as a whole, if the special-interest sections and a few other faults be excepted, and constituted a marked improvement over the existing Code. But various persons, who objected to this or that sane provision or healthful restriction,

came forward under cover of the great protest against the venal clauses and voiced their opposition against every restriction or progressive clause. The needed extension of the fire-limits was opposed as an unwarranted hardship. Discretionary administration of the law, which has been loudly demanded for a number of years past, chiefly by architects, and therefore was specifically provided for in the new ordinance, was denounced by architects themselves as a well-devised instrument for oppression and favoritism. Examination and registration of engineers, architects and builders, a promising method for the much-needed regulation of building work, was similarly branded. Most surprising of all, perhaps, sharp criticism was directed at all those parts of the ordinance which aimed to secure efficient fireproofing, with the specious argument that removal of all restrictions on fireproofing would make it cheaper and therefore encourage its use.

The net effect of such misguided opposition is to confound the good and the bad in the recently-defunct ordinance in one common opprobrium, and increase the improbability of securing a sound and effective ordinance at the next attempt.

At the same time we see that the task of discriminating between good and bad requirements, between sound and unsound protest, must be placed into more capable hands than Aldermen's. The difficult and delicate work of framing a building law needs highly-trained, honest and impartial men. Since, unfortunately, the State has placed this work in the hands of the Board, there is urgent necessity that competent, disinterested advisers should lend aid in the work of Code-making, not merely destructive aid after the work is done, but constructive aid from the beginning.

That civil engineers have vital concern in this work was made apparent when members of the American Society of Civil Engineers hastily banded together a few weeks ago to make united protest against the proposed Code. Why should not these men, or that society itself, take authoritative part in drafting the Code, and if not asked, *insist* on taking part in it? Why should not the American Institute of Architects similarly enforce its claims upon doing its share toward protecting the public? If the architect and engineer have a function as citizens, surely their duties in just this kind of public labor are obvious! But we admit that the assumption of this public duty would mean the abandonment of the dignified inactivity which seems to mark such societies.

The problem of converting into useful fuel the stores of carbon locked up in the peat deposits of the world has long attracted the study of scientists and engineers. The great obstacle to economically producing peat fuel in commercial quantities has been, and is, in the 90% of water which is held by the 10% of peat sponge, and most of which must be expelled some way or other. A simple calculation will show that it requires a few more heat units to evaporate the 90% water from the 10% combustible than are released in burning the latter. Artificial drying has proven useless as might have been expected.

The water, somehow, has also refused to be squeezed out, by mechanical processes. Either the whole mass of raw peat pulp would flow through the screens or the screening walls would be burst apart. The few processes that up to the present have placed peat fuel on local markets in commercial forms and quantities have depended primarily upon air drying to reduce the water contents and to put the peat into a workable condition.

The reason behind the difficulty of pressing the water out of peat sponge is now disclosed by researches described in a paper before the recent meeting of the Iron and Steel Institute. This paper we have reprinted elsewhere in this issue. Dr. Ekenberg there shows that all the trouble has been due to the presence of a jelly or a slime, chemically termed hydrocellulose. The simplicity of the process, for removing this jelly, is striking. The mere application of heat, sufficient to raise the temperature of the hydrocellulose to 150° C. has been shown to split it up into water and a caramel or sugar. Once the jelly has disappeared the peat substance may be mechanically pressed as any spongy material would be.

Processes depending largely on air drying to put the peat pulp into workable peat have had a certain degree of success, but they have never overcome the handicap imposed by weather and season. There are no such limitations to mechanical treatment, and if these experiments develop a process, as practical and commercial as Dr. Ekenberg's account claims to be possible, truly they have unlocked a great storehouse of fuel hereto practically sealed.

The Comparative Merits of Bridges and Tunnels for Crossing Navigable Waters.

There are certain engineering problems which are continually bobbing up afresh for solution. A notable example in this country was the problem of the Brooklyn Bridge terminals, which for fully 20 years brought gray hairs to successive engineers and commissioners and public officials.

In far away Australia a problem which seems to match our own Brooklyn Bridge terminal problem in longevity is the question how to cross the harbor of Sydney. This problem has a special interest in this country because some American engineers have had a hand in solving or attempting to solve it, and at one time a contract for a great bridge across the harbor seemed likely to come to the United States.

Now, however, an engineering commission has recently reported that the best solution for the Sydney crossing is not a bridge, but a tunnel or rather a number of tunnels. On another page of this issue we have printed an account of the Sydney Harbor problem and of the method now recommended for its solution. The recommendations of the Commission for Sydney make appropriate a discussion of the general question of the comparative merits of bridges and tunnels, a question in which many of the large cities of the world are deeply interested.

In this country for example, we may instance New York with its new tunnels under the North River and both bridges and tunnels across the East River; Chicago with both bridges and tunnels across the narrow inlet of the drainage canal known as the Chicago River; Philadelphia with one bridge across the Delaware and a project for a tunnel beneath it now being actively agitated; Detroit with a tunnel under the river in front of it now nearing completion; St. Louis now agitating for additional bridges across the Mississippi. Abroad we may cite London with both bridges and tunnels across the Thames, Paris with the narrow Seine crossed by many bridges and a few tunnels for underground railway lines, and Liverpool with its tunnel under the Mersey.

In discussing the relative merits of bridges and tunnels for river crossings, we would disclaim at the outset the idea that any hard and fast rule can be laid down to govern all cases.

There is quite too much of a tendency to do that very thing in engineering—to urge for example, the choice of tunnels at one place because tunnels have been chosen at another. We would emphasize, on the contrary, that every engineering problem ought to stand by itself. The proper solution for it can only be determined with a full knowledge of the local conditions. At one city the topography and geology may make tunnels obviously preferable. At another the advantages of bridges may be equally evident to the experienced and competent engineer.

With this fact clearly in mind, we would raise the question whether the tendency at the present time is not to overrate the advantages of the tunnel as a means of crossing the rivers adjacent to great cities. It would not be at all strange if this were the case. So much has been said in the public prints about the great advantages of tunnels compared with bridges ever since the starting of work on the North and East River tunnels for the Pennsylvania railroad entrance to New York city, that the public—the financial public, which furnishes the money for engineering work and tells engineers what to do and sometimes how to do it—has probably formed exaggerated opinions as to tunnels and tunneling.

It is a fact, of course, that the development of submarine tunneling is comparatively recent. Nearly all the under-water tunnels at great cities, both here and abroad, have been built within the past 20 years, and most of them in the last ten years. The engineering profession has learned a great deal about submarine tunneling during that time, and particularly has it gained knowledge regarding the cost of such work. It is pretty well understood now that submarine tunneling, under the conditions existing around New York city is very much more expensive than was supposed when the work of under-river tunneling was launched so vigorously half a dozen years or so ago. A great many millions of dollars have been buried in the construction of these tunnels, so many that there is reason to believe, if the choice were to-day again presented to the Pennsylvania Railroad Co. of a bridge or tunnel entrance to New York City, and if the present knowledge of tunneling cost were still available, the choice would be for bridges rather than tunnels.

And the great cost of the work of tunneling is not the only factor that would influence the choice. It is better appreciated now than formerly how very limited is the traffic capacity of a double-track tunnel, particularly for handling the dense rush-hour crowds of suburban traffic. A great bridge may have four or six or even eight tracks, and the cost will not be increased at all in proportion to the number of tracks. But if traffic demands as many as six or eight tracks, the cost of tunnels will increase almost in proportion.

Again the efficiency of tunnel operation depends very largely on the possibility of providing ample terminal facilities, and this cannot be done underground, except at an expense well nigh prohibitory. The traffic capacity of tunnels is closely dependent on this. For illustration, the St. Clair and the Detroit tunnels with only two tracks have nevertheless an enormous traffic capacity. They have sufficient open air terminals at each end to make up and dispose of trains, and their traffic is through traffic which can be evenly distributed over the 24 hours and which permits very long trains to be handled. In contrast, the Hudson companies' tunnels at New York have all their terminals underground in a contracted space. These tunnels handle largely commutation traffic concentrated in the rush hours, and the train length is limited.

Admittedly the cost of maintenance of a tunnel structure is very much less than the maintenance of a bridge; yet this is offset by the greater cost of track maintenance in a tunnel and by the cost of lighting and ventilation. The relative safety is not an important consideration since, with modern interlocking signals and train controlling apparatus, either bridge or tunnel can be operated with a high degree of safety. Railway operating officers, however, always prefer bridges to tunnels, and there is little doubt that trains can be handled more promptly and at higher safe speed in the open air.

The cases where tunnels can be advantageously substituted for bridges for railway river crossings are confined almost or quite exclusively to the streams of great width where the bridge structure becomes very costly. On channels of any moderate width, the bridge is not only far cheaper to construct, but its level is much nearer the general level of the railway. Every dip above or below the grade line costs money, and it is just as expensive to lower trains down to the level of a tunnel say 100 ft below the normal profile and haul them out again as it would be to handle the same traffic over a hump in the grade line 100 feet high.

It is true that with electric locomotion grades are now feasible that could not at all be attempted with steam locomotives and that long tunnels have a large part of their ventilation difficulties solved by the use of electric traction. Nevertheless hauling trains over grades

and carrying on ventilation costs money and this expense should not be overlooked in any engineering comparisons.

To many of our readers these facts may seem so simple and self-evident that it is not worth while to set them down; but so much has been published in the popular journals tending to mislead people as to the advantages of tunnels over bridges that it has seemed worth while to set down these few considerations even though they be elementary.

LETTERS TO THE EDITOR.

Tensile Tests on Natural Cement Mortar.

Sir: In connection with the restriction placed on natural cement by the Revised Building Code of New York City, lately passed by the Board of Aldermen and vetoed by the Mayor, the following tensile tests of mortar briquettes made of one brand of an "improved" natural cement may be of interest to the profession. The mixture was 1 to 3 standard quartz sand, except in the case of the middle column, for which 1 to 2 was used:

	STRENGTH IN LBS. PER SQ. IN.						
7 days.....	65	80	80	137	85	95	70
28 days.....	167	170	165	280	195	202	175
60 days.....	230	232	215	355	277	260	230
90 days.....	287	282	270	437	302	282	307
180 days.....	425	390	390	465	420	467	442
1 year.....	405	437	390	552	442	465	487
2 years.....	462	512	450	567	535	485	537
3 years.....	450	457	440	525	485	492	535
4 years.....	500	442	520	552	510	500	500
5 years.....	470	475	430	...	498	560	515

The writer can quote several long-time tests of well-known brands of Portland cement which have not behaved nearly so well as this brand of natural cement. The value of such a cement for many varieties of engineering work is obvious. Yours very truly,

Henry H. Banks.

187 Greenwich St., New York, July 19, 1909.

The Proposed Municipal Members on the Directorate of a Baltimore Gas Company.

Sir: We have noted with regret the leading editorial in your issue of July 8, 1909, with regard to the proposition to introduce natural gas for use in the city of Baltimore. It is evident that you have obtained the information upon which this expression of opinion is based, entirely from prejudiced articles contained in certain Baltimore newspapers.

In order to inform you on this proposition we enclose herewith correspondence between the Consolidated Gas, Electric Light & Power Co. of Baltimore and certain business men of that city, in the form of a printed pamphlet which was forwarded by the company to all of its 85,000 consumers, from 65,700 of whom, by the way, it obtained responses favorable to its proposition with less than 300 against.

The following principal points are embodied in the proposition of the company:

(1) The average price of gas to householders is reduced from the present rate of $1 for artificial gas to an average rate of from 43 to 45 cts. for natural gas, and it is understood that a rate of from 15 to 18 cts. per 1,000 cu. ft. will be made for the sale of gas for manufacturing purposes.

(2) While the prices proposed for natural gas are somewhat higher than those in force in Pittsburg, Buffalo and Cleveland, due largely to the longer haul of the gas, in order to assure the public that there will be no excessive profit made on its sale at these figures, the company has agreed to divide with the city surplus earnings remaining to the company in excess of 4% upon its present common stock. The reasonableness of this offer will be appreciated when it is understood that under present conditions this common stock is stated to be upon an earning basis of 6%.

(3) For the purpose of safeguarding the interest of the city in this proposed division of net profits, the company has offered to place five nominees of the mayor and governor upon its board of directors.

(4) The company has a perpetual franchise for supplying gas under which we are informed gas can be supplied at $1 per 1,000 cu. ft., and therefore it is not asking for any additional rights from the city.

We cannot see but what this arrangement is a fair one to the city and to the consumers, inasmuch as it cuts the present domestic gas rate more than in half, and gives the city the benefit of natural gas for its manufacturing plants, at the same time assuring it against excessive profits; and on the part of the company it is merely a reasonable contractual relation to warrant the expenditure of the large amount of new capital necessary to bring the natural gas to Baltimore.

Very truly yours,

Ford, Bacon & Davis.

115 Broadway, New York City, July 9, 1909.

[Our comments had nothing whatever to say about the general gas proposition in question. They dealt entirely with the delusive proposal to safeguard the interests of the city by giving it a small minority representation on the board of directors of the company. The opinions which we expressed were the same as we have held on this point for years past, except as they were extended to cover this particular case. In the present Baltimore instance it has been argued that a minority representation on the company's directorate, which of course would be absolutely powerless, would be better for the city than a general public-utility commission, which would of course be superior to the gas company as well as other companies.—Ed.]

Facilities for Training Health Officers at the Massachusetts Institute of Technology.

Sir: I have a further reference to your editorial statement of April 15, 1909, as quoted by Dr. Hodgetts in the issue of July 8. The statement I refer to is the following:

". . . There is not, in the United States at least . . . any adequate means of training health officers."

I beg to mention the fact that for many years such a means of training has been afforded by the Department of Biology, Massachusetts Institute of Technology. Reference to the current catalogue will show a course, leading to the degree of S. B., in sanitary (and industrial) biology, the main object of which is to train men for efficient public service in sanitary science. On a thorough technical training in general biology, chemistry, physiology and bacteriology is based instruction in the biology of the infectious diseases, municipal laboratory methods, vital statistics, and all other important aspects of the public health.

This is an undergraduate course, not requiring the M. D. for admission; hence the route is more direct, and, for those who become engaged in public hygiene, there is less discarding of technical training (or, for example, clinical medicine) irrelevant to hygienic administration.

The Massachusetts Institute of Technology course has been for years under the direction of Professor W. T. Sedgwick, some time Biologist to the State Board of Health of Massachusetts, and is therefore intimately connected in tradition with the first state in the Union in sanitary affairs.

It is regrettable that at least the pioneer school of public health in this country should not be more widely recognized, and the lack of wide recognition demonstrates a need for public knowledge of the fact that this is a necessary and remunerative form of public service.

You are at liberty to use parts or the whole of this letter for publication if it will serve to draw attention to an important fact. Yours very truly,

J. Scott MacNutt.

Assistant Biologist to the Pittsburg Typhoid Fever Commission.

Nantucket, Mass., July 15, 1909.

[Several of the editors of this journal have the good fortune to live in a town which for all save one year out of the past fifteen has had as its chief health officers men trained at the Massachusetts Institute of Technology, under Professor Sedgwick and others, but generally in the sanitary engineering course. We believe that many of the men trained for four years in the course our correspondent has outlined are, or with practical experience would be, far superior as health officers to graduates of medical schools who had taken a year or so of the work required for a diploma of public health at the Canadian or the British universities. While we might well have qualified our editorial remarks so as to give recognition to the admirable work done and being done at Boston, what we said expressed, in the main, what we had in mind at the time: a lack of a carefully formulated course of study, designed primarily and solely to fit men, from start to finish, for the position of health officer, and so recognized by the public. We confess, however, that we have not seen, in recent years, the outline of study to which our correspondent refers. If our remarks did an injustice to the Massachusetts Institute of Technology, or any other institution, certainly no one regrets it more deeply than we.—Ed.]

The Petrolithic Pavement.

Sir: The materials entering into the finished petrolithic pavement consist of the earthy matter of which the road is composed, a comparatively small quantity of broken stone and a special heavy asphaltic oil.* The said oil should carry not less than 80% of asphaltic contents.

[*Three articles on the use of heavy asphaltic oil in road construction in California were published in our issue of April 4, 1907. One of these dealt with what is known as petrolithic construction and the use of the tamping roller at Santa Monica, Cal.—Ed.]

The construction of this pavement consists in the thorough mixture of the earthy matter and stone with the oil (which acts as the matrix); and the subsequent consolidation of the whole oiled mass by means of a roller tamper "having separate compression shoes," or feet-like projections extending from the surface of the cylinder of the roller. Whether the material is soil, sand, gravel, worn-out macadam or other granular and stable material, makes little difference as to the final good character of the completed pavement.

A petrolithic pavement may be correctly described as a conglomerate mass, whose gangue is earthy matter or sand, with gravel, old macadam or broken stone, and whose matrix is an asphaltic oil which will not, in a few years, become a solid having a brittle property under temperatures as low as 20° F.

The prime requisite for a petrolithic pavement, as it is for all other pavements or roads, is a stable foundation. Whether this foundation is to be obtained in soil, clay, sand or gravel, it can be secured in 99 out of 100 cases by proper drainage. Keep water from reaching the foundation, which may be composed of either of the above materials, then will a 6-in. petrolithic pavement, when properly constructed, maintain its even and smooth surface under any traffic excepting, probably, that to be met with in the heavy freight thoroughfares of a large city.

The life of the pavement is dependent upon the life of the oil matrix. That is, as long as the oil retains its inherent primal qualities, both physical and chemical, just so long will the pavement endure the traffic to which it is subjected (with the above exception). As to the conditions to be met on street and roadway surfaces, the life of the oil has not been fully determined. However, this much I have observed, that the cost of repairs to a petrolithic pavement, after it had been in use for five years, did not exceed a few cents per square yard; and this was on roads which were built when knowledge of, and experience with, petrolithic pavements were almost nil. Built to-day, in accordance with knowledge gained through past experience, and judging from what I have seen of many miles of these pavements, I have no hesitancy in affirming that the cost of repairs, after the pavement shall have been in use for ten years, will be comparatively insignificant.

The entire first cost of the petrolithic pavement, in the State of Georgia, will not exceed that of a first-class macadam pavement, in which good materials and good workmanship shall have been used.

The petrolithic pavement strongly resembles sheet asphalt and bitulithic pavements in their grayish black color, and in their smoothness and evenness when the latter pavements are in good condition. Its texture, on the surface and after the screening course shall have been compacted, resembles that of a terraza floor, excepting in the size of the stone fragments that will show on the surface. It is not as hard as sheet asphalt, but at all temperatures, due to the proper aggregation of the materials composing it, it offers sustaining powers practically as great as those of the two pavements just next above mentioned. Its tractive resistance is but little, if any greater than that of sheet asphalt. It is practically impervious to, and non-absorbent of, water. Under the extreme heat of the sun it is no softer than a bitulithic pavement; while at very low temperatures it will not crack as does asphalt. During the life of the oil, which is not less than seven years, this pavement is dustless and mudless, excepting at those points where dust and mud are conveyed onto it from near-by sources. It is productive of less noise under traffic than any pavement ever constructed. Due to the property of the matrix (that is, due to the adhesiveness of the oil) of this pavement, and during the life of the said matrix, there will be a tendency of the pavement to increase its mass by accretion and it will not tend to wear away as all other pavements are prone to do under usage. Under no conditions, excepting when it may be covered with ice, is this pavement slippery; and further, it offers a perfect foothold for horses. From the foregoing remarks it is evident that the very nature of the pavement renders it the most perfect from the viewpoint of good sanitation.

The above statements are based upon my own observation and study of petrolithic pavements in Los Angeles, Pasadena, Monrovia, Santa Monica, Glendale and Ventura, Cal.; in El Paso, Tex.; and of the Imperial pavement in Kansas City, Mo.; of the oiled macadam in Riverside, Cal.; and of sheet asphalt and bitulithic pavements in various parts of this country.

Petrolithic pavements are usually made 6 ins. thick. Although it has not been as yet fully demonstrated that this is the most economical thickness, it has given excellent and satisfactory results where it has been properly constructed with oil of good quality.

This pavement, for purposes of description, may be divided, horizontally, into three divisions. The first division, which is at the base of the pavement, is composed, mainly, of oiled earth and may be from ½ to 5½ ins. thick. It performs the duty of distributing the loads over larger areas of the foundation, and acts, partially, as an oil reservoir.

The second division, or the broken stone division, may be from 5½ to ½-in. thick, depending somewhat upon traffic conditions. The action of this division is to distribute the loads over greater areas on the first division, or the base of the pavement, and to give rigidity to the upper portion of said pavement. It gives this rigidity, which is resistance to lateral movement of the stone fragments under loads, from the forces of friction and adhesion inherent within the stone fragments themselves. This division is rendered impervious by the nature of the oiled earth which fills the interstices between the stones.

The third division comprises the screening course, or wearing surface, of the pavement and should be not less than ½-in. in thickness. This division of the pavement must carry the traffic of the roadway without rutting or buckling, and it must be non-absorbent and impervious to water. The materials entering into the construction of this screening course must be of the best quality available, for, largely, the excellence and life of the pavements depend thereon. The screenings should be of the hardest and toughest stone to be had, and the fragments thereof should not be of uniform size. The crusher dust should not be screened out but should be uniformly incorporated with the mass of said screenings.

The oil used should be a heavy asphaltic oil carrying 99.3% of bitumen soluble in carbon bisulphide. It should carry not less than 80% of asphaltic contents, which at a temperature of 77° F. should have a penetration of 80° District of Columbia standard. Its specific gravity should not be less than 0.98. It should not contain free carbon in suspension, nor should it ever have been subjected to the process known as "cracking" in the distillation of petroleum products, nor should it ever have been exposed to a temperature greater than 600° F. in any stage of its manufacture. When applied to the material of the pavement it should have a temperature of not less than 150° F., nor more than 200° F. This temperature should be obtained by means of steam. The total quantity of oil applied per square yard of pavement varies from 2½ to 3½ gals.

The machinery that is indespensable in the construction of petrolithic pavements comprises rooter plows, gang plows, cultivators, spiked disk harrows, Fresno drag scrapers, road graders, oil wagons, heating plants and the roller tamper.

The roller tamper is a machine consisting of a cylinder (cut into two lengths transversely) whose surface is provided with "separate compression shoes" or feet-like projections attached to and extending outwardly from the outer surface of the cylinder. The action of the roller tamper resembles that of a herd of cattle, in that at each step, or under each foot, a small portion of the loose earth is compacted on the foundation, first; which action is continued until the whole mass is thoroughly and uniformly consolidated from the very base of the pavement to its top, thus obtaining a pavement of a hard and homogeneous character.

As I first remarked, it makes little difference whether the material, of which the road to be improved is composed, is soil, clay, sand, gravel or old macadam; for petrolithic pavements are constructed of any of these materials by the addition of broken stone, where gravel or old macadam may be wanting, and by the addition of the screening course for the wearing, impenetrable and non-absorbent surface. Also, as I have mentioned above, the foundation of the pavement must be protected so as to prevent water reaching it from the sides or from below. This protection can be easily obtained by proper drainage, principally by means of side ditches or gutters, which latter must be water tight.

Briefly, the methods of construction are as follows: The surface of the roadway is brought to the proper elevations and form of cross-section which the finished pavement is to have, excepting that at those points where the newly-made grade is in fill it should be higher so as to allow for the compaction of the earth under the action of the roller tamper. The roadway is then to be plowed to a depth of 6 ins. below the grade of the finished pavement, and the earthy matter is to be thoroughly pulverized. Both before and after the pulverization, the earth may be moistened.

After the pulverization of the earth, a first application of oil is made and is thoroughly mixed with the loose earth. A second and a third application of oil is made and mixed with the earth after each application. After the third application of oil and its incorporation with the earth, the whole mass is to be turned completely over by means of gang plows, after which the surface of the oiled mass is shaped into the required form of the finished pavement by means of a road grader.

The oiled earth is then to be tamped with the roller tamper, until the feet of the tamper tread on the surface of the compacted mass. At times during the process of tamping, water should be added to the oiled earth in order to bring it to the proper consistency for tamping, and for more thoroughly mixing the oil and earth, and kneading the whole oiled mass, by means of the roller tamper, so that the tamping should proceed from the bottom up, and that the petrolithic layer should be of a hard and homogeneous character.

When this tamping is completed and the surface has the proper shape of cross-section, a layer of stone, of designated thickness, is spread evenly over the surface of the tamped portion of the roadway. (When the material of the existing road is gravel or old macadam, then it will not be necessary to add this broken stone.) After the stone is spread, the roadway is to be plowed to a depth below the surface of the previously tamped portion equal to the thickness of the layer of stone added, measured loose. The plowed mass of earth and stone is to be mixed together and brought to an even surface, conforming to that of the finished pavement.

A fourth application of oil, in an amount depending on the thickness of the layer of stone added but usually about ¾-gal. per sq. yd. for each 2 ins. of stone, is then to be made. This oil is to be thoroughly mixed with the mass of earth and stone, which should be tamped with the roller tamper until the feet thereof tread on the surface of the compacted mass.

The surface is now rendered smooth and is moistened and a fifth application of oil, amounting to ¼ to ½-gal. per sq. yd., is made and is immediately covered with a layer of stone screenings ¼ to ½-in. thick. The largest dimension of the screenings shall not be greater than the thickness of the layer spread. This layer of screenings may be left for the ordinary traffic to compact, but it would be best, probably, that it be compacted at once by a specially devised roller made up of many individual wheels, and to pass this roller in an irregular line of travel over the whole surface of the pavement. I do not favor the use of the plain road roller for the consolidation of this screening course, or of any other course of a petrolithic pavement.

The profile of the cross-section of the finished pavement should be that of a vertical curve whose vertex, or crown, should be above the gutter ¾-in. for every foot horizontal that the crown is distant from the gutter.

D. Lee Wardroper,
Civil Engineer.
326 Candler Building, Atlanta, Ga.

[We have learned through Mr. Wardroper, since his letter was put in type, that he has acquired the patent rights to use the roller tamper in Georgia; also that his letter was originally prepared "to give information to users of roads in Georgia." The "petrolithic process" of road construction, Mr. Wardroper states, is not patented, but he adds that the use of the roller tamper is essential to the process of construction. We give this information in order that our readers may be fully apprised of Mr. Wardroper's relations to the system of road construction which he describes so fully and interestingly.—Ed.]

Bridge and Tunnel Projects for Crossing the Harbor at Sydney, New South Wales.

The city of Sydney, New South Wales (Australia), is situated on the south side of the great land-locked harbor known as Port Jackson, and on the north side there is a large and rapidly developing suburban district. The population of this district is increasing at the average rate of 6% per annum, and is estimated to reach 207,000 by 1927. The rapid-transit traffic of the district, including suburban railways and street railways, increased 68% in the period from 1901 to 1907, and aggregated 14,457,000 passengers in 1907.

The situation is not unlike that of New York City and the New Jersey suburban district previous to the completion of the tunnels for rapid-transit service. All passenger communication between the city and the northern suburbs is effected by five lines of steam ferryboats, operated by the Sydney Ferries Co., the total annual traffic of which is estimated at 13,000,000 passengers. In addition, there are two ferries for vehicular traffic, which carry together about 430,000 vehicles annually. There are other ferry and steamboat lines to more distant parts of the harbor, but these may be neglected in considering the question of direct communication across the harbor.

The largest of the ferryboats are double-deck steamers carrying from 1,250 to 1,350 passengers each, and having seating accommodation for about 1,000 passengers. The service is said to be good, but the enormous growth of the traffic indicates the need of some better system of communication. The ferry company considers it can deal with the increasing traffic by putting on larger boats and running a more frequent service. On the other hand, this would increase congestion of traffic in the harbor and the difficulty (and danger) of navigation, especially in view of the steady increase in the shipping traffic of the port of Sydney. Occasional dense fogs are experienced in the harbor. Another difficulty is that the ferry lines converge at one point (in Sydney Cove) on the city side, diverging to different points on the suburban side. Now serious accidents have occurred to the ferryboats, but there is more or less danger attendant upon the service, and this danger increases with the traffic. The routes of the ferries are shown on the map, Fig. 1.

Under these conditions it is natural that some improved means of communication should be sought, and numerous projects have been put forward at various times. As early as 1878 there were projects for a fixed bridge and a floating bridge between Dawes Point and Milson's Point. In 1900, and again in 1901, the government advertised for competitive designs and bids for a bridge between Dawes Point and McMahons Point. This project, and the specifications relating to the design, were described in our issue of July 25, 1901. The board appointed to pass upon the designs in the latter case recommended the adoption of that submitted by J. Stewart & Co., of Sydney, which was illustrated in our issue of Sept. 22, 1904. This design provided for a cantilever bridge having through trusses and a single deck; the channel span was to be 1,350 ft. long c. to c. of towers, with anchor arms of 500 ft. at the south end and 580 ft. at the north end. Long approaches were required in order to reach the elevation necessary to give a clear headway of 170 ft. above high water at the middle of the channel span. The bridge was to carry (on one level) a 35-ft. roadway, a double-track street railway, and a double track steam railway; also two 10-ft. sidewalks outside of the trusses. The total estimated cost was $9,700,000, of which the main bridge (3,030 ft.) represented $6,825,000.

The report in favor of this design was made at a time of financial depression in the colony. No action was taken by the government, and nothing further has been done in the matter. Since then, the completion of the new central passenger station (Engineering News, March 30, 1905) has somewhat changed the conditions in regard to approaches and railway connections.

In May, 1908, a commission was appointed by the king to investigate and report upon the best practical method of establishing direct communication between the northern and southern sides of the harbor, which would both avoid obstruction to navigation and provide the best route for such communication. This commission was composed of Maurice S. Kernot, M. Inst. C. E., M. Am. Soc. C. E., Henry Deane, M. Inst. C. E., and Charles N. J. Oliver.

Their report, made under date of March 29, 1909, reviews the general conditions as described above, and also the various bridge and tunnel projects. Among the latter was a subaqueous viaduct proposed by Mr. A. M. Howarth, M. Inst. M. E., Assistant Engineer in the Public Works Department, who had designed a system of this kind several years ago. (Engineering News, Jan. 21, 1897.) This structure was to be a "tube" about 16 × 47 ft. inside (divided into four compartments by vertical walls), in spans of 225 ft., resting on pairs of cylinder piers sunk to rock. Special tunnel designs were prepared at the request of the commission by Mr. H. H. Dare, Assoc. M. Inst. C. E., Assistant Engineer in the Public Works Department, and Mr. W. Hutchinson, M. Inst. C. E., Chief Engineer for Railway Construction (of the government railways). The former proposed a high-level tunnel consisting of tubes sunk in sections in a trench dredged in the bed of the harbor, on the system adopted for the Michigan Central Ry. tunnel (now practically completed) for crossing the Detroit River at Detroit (Engineering News, Oct. 31, 1907, and Sept. 24, 1908). The latter proposed a deep tunnel driven by the shield system, and lined with cast iron, having the crown about 64 ft. below low water. The soft deposit in the bed

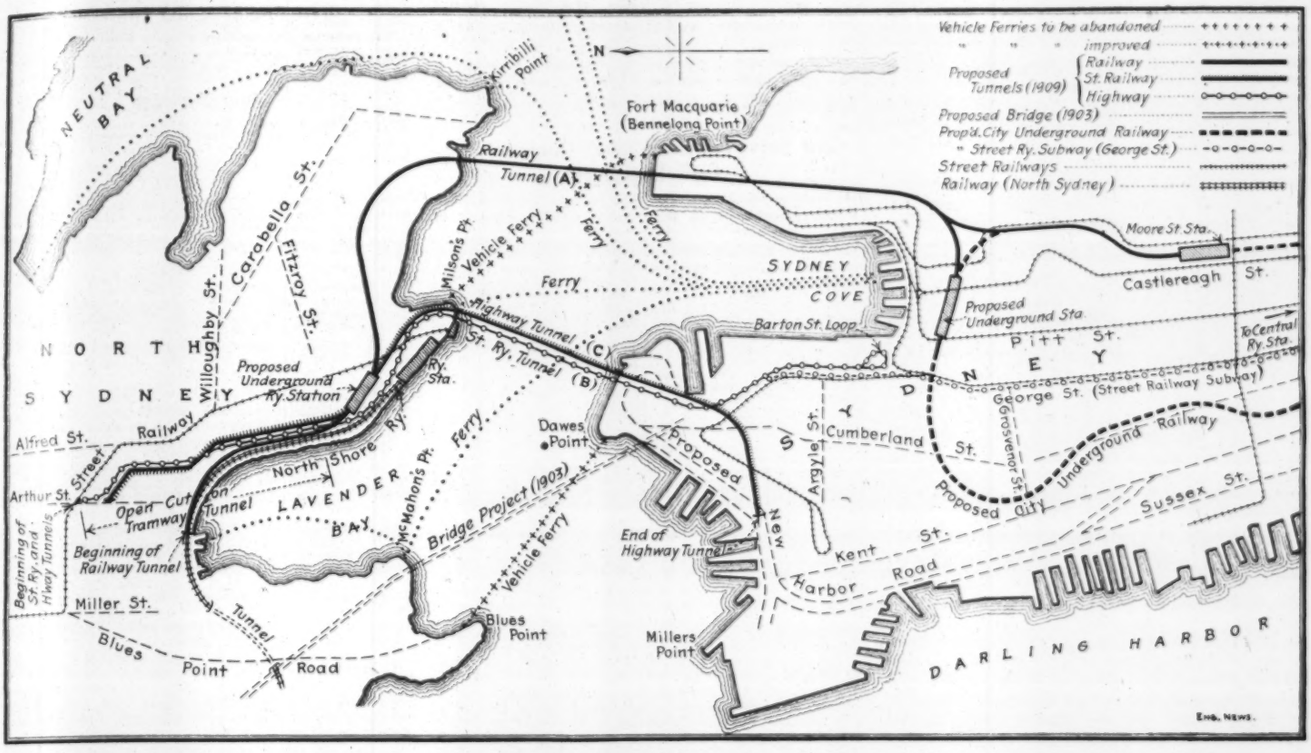

FIG. 1. MAP SHOWING THE PRESENT AND PROPOSED FACILITIES FOR CROSSING THE HARBOR AT SYDNEY, NEW SOUTH WALES (AUSTRALIA).

(The ferries form the present facilities, and the tunnels have been recommended recently by an engineering commission. The bridge was recommended in 1903, but the present commission considers the tunnels more advantageous than a bridge.)

of the harbor is largely of a sandy character, with irregular beds of clay.

The bridge project is not regarded by the commission with favor and it is pointed out that owing to the necessarily great height of the bridge (170 ft. above high water), the low-level area adjacent to it at North Sydney could not be served conveniently, and the residents would probably continue to use the ferry service. Furthermore, the position of the northern pier (in the water) was objected to. But as a larger central span would greatly increase the cost, this pier would have to be accepted as a necessary, though not very serious, obstruction to navigation. The naval and military authorities who gave evidence before the commission considered that a tunnel would be preferable to a bridge. The report states that to increase the capacity of such a bridge in the future (involving the strengthening of the structure) would be almost impracticable and certainly very expensive. On the other hand, additional tunnels could be built without difficulty, as traffic might require.

The commission's report discusses the tunnel question in its relation to the accommodation of railway, street railway and highway traffic. As to the first, the line should connect the suburban railways of North Sydney with the new central station in Sydney. As to the second, it is recommended that the cars of the suburban lines should be run through between the city and the suburb. One proposition was to have a terminal for these cars on the north side, requiring passengers to use the trains for crossing to the city. This would cause delay and inconvenience, with the result of diverting some traffic to the ferries.

As to the third class of tunnel, reference is made to the two great Blackwall and Rotherhithe highway tunnels under the Thames at London, the latter of which was very fully described in our issue of Dec. 19, 1907. It is considered doubtful whether the vehicle traffic at present calls for anything beyond better and faster ferry service, but in point of harbor navigation the vehicle ferry between Fort Macquarie and Milson's Point is the most objectionable of all the services across the harbor. The commission proposes, therefore, that this ferry be abandoned, and all vehicle traffic handled between Dawes Point and Blues Point by larger vessels and more frequent service until such time as the highway tunnel becomes necessary.

The commission arrives at the conclusion that subways or tunnels provide the best and most economical method of establishing communication. Also that the railway and street railway tunnels should be designed to permit the passage of standard rolling-stock, with electricity as the motive power. Their reasons include both local conditions and general principles, and may be summarized as follows: (1) subways will not obstruct the harbor in any way, while any practicable bridge must have a pier in the harbor; (2) the combined capital cost of the necessary subways for all classes of traffic would be considerably less than that of a suitable bridge; (3) tunnels for railway, street railway and highway traffic could be undertaken and completed separately and independently, while with a bridge the whole structure must be completed before any of the respective services would be available; (4) tunnels would be convenient and comfortable, and would enable railway and street railway passengers to reach the different parts of the city more easily than by bridge; (5) the railway and street railway systems could be

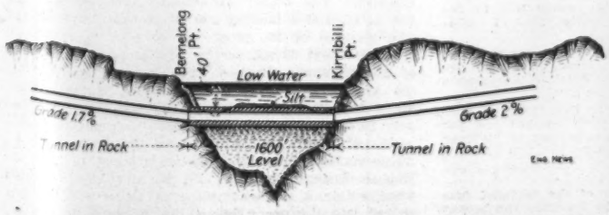

FIG. 2. PROFILE OF PROPOSED RAILWAY TUNNEL UNDER THE HARBOR AT SYDNEY, NEW SOUTH WALES.

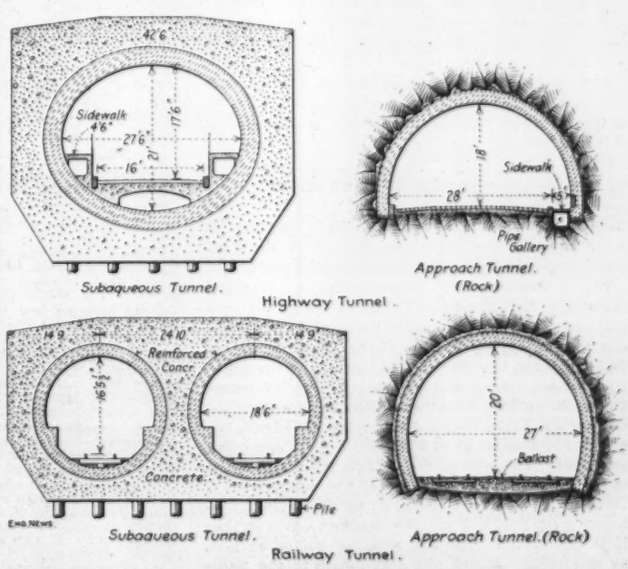

FIG. 3. CROSS SECTIONS OF PROPOSED RAILWAY AND HIGHWAY TUNNELS UNDER THE HARBOR AT SYDNEY, NEW SOUTH WALES.

connected more satisfactorily for through traffic by tunnels than by a bridge; (6) increased accommodation, when required, could be provided more economically by additional tunnels than by a bridge.

The tunnel system as proposed by the commission comprises three separate lines of tunnels, and the routes are shown on the map, Fig. 1.

(A). RAILWAY TUNNEL.—From Lavender Bay, on the north side, by Kirribilli Point and Fort Macquarie to a station at Moore St., Sydney. Distance, 2 miles. Estimated cost, $3,765,000. This estimate is for a double-track tunnel and includes the station ($400,000). The cost for two single-track tunnels (and including station) was estimated at $3,945,000. A partial profile of this tunnel is shown in Fig. 2. The subaqueous section is level, and 1,600 ft. long, with rock tunnel approaches having grades of 1.7% on the south and 2% on the north. The cross section of the subaqueous section is shown in Fig. 3. The approaches are double-track tunnels of horseshoe section 27 ft. wide at the springing, with a headway of 20 ft. above rail level at the center and not less than 16 ft. over the outer rails.

(B). STREET RAILWAY TUNNEL.—From Arthur St., North Sydney, by way of Milson's Point and Dawes Point to a surface terminal loop at Barton St., Sydney. Distance, 1⅛ miles. Headway, 15 ft. A sidewalk would be provided in the approaches. The subaqueous section would be 1,416 ft. long, and level, with approach grades of 3% on the south and 5.7% on the north. At the city end, the tunnel might be connected with a proposed shallow subway under George St. to the Central passenger station. This would be of rectangular section 24 ft. wide, with a height of 15 ft. above the rails. The subaqueous portion would be very similar to that of the railway tunnel (Fig. 3), with tubes 17 ft. inside diameter and a headway of 15 ft. above the rails. Each approach would be a double-track rock tunnel with a semicircular roof of 15 ft. radius, and a headway of 17 ft. 6 ins. at the middle; 25 ft. of the width would be for the roadbed and 5 ft. for a sidewalk, under which would be a pipe gallery.

(C). HIGHWAY TUNNEL.—From Arthur St., North Sydney, by way of Milson's Point and Dawes Point, to a connection with a new water front road proposed by the Sydney Harbor Commission. Distance, 1⅛ miles. Estimated cost, $2,510,000; this is exclusive of $150,000 for the road approach, which should be a joint charge with the street railway tunnel, but for convenience has been charged entirely against the latter. The subaqueous section would be 1,416 ft. long, and level. It would be of oval section 21 × 27½ ft., with a 16-ft. roadway and two 4½-ft. sidewalks, as shown in Fig. 3. The approaches have grades of 4% on the south and 5.75% on the north. These are rock tunnels with arches of 16 ft. 6 ins. radius, and a headway of 18 ft. at the center. The roadway is 28 ft. wide, with a 5-ft. sidewalk and pipe gallery on one side.

In all these tunnels, the subaqueous portion is on the system proposed by Mr. H. H. Dare, and based upon the method adopted for the Detroit tunnel, as mentioned above. This portion is level in each case, and has the top of the concrete covering 40 ft. below low-water level.

The annual revenue is estimated at $300,000 ($240,000 for passengers and $60,000 for vehicles). This would practically meet the interest charge (at 3½%) on the capital expenditure of $8,575,000 for the three tunnel lines. If the highway tunnel was postponed, the $240,000 revenue from the other lines would meet the interest charge of $212,275 on their cost of $6,063,000, and leave a balance of $27,725 towards operating expenses. The cost of the bridge and connections is estimated at $12,905,000. If the revenue from this bridge was as above it would leave a deficiency of $151,675 on the interest charges, but it is considered that the revenue would be less, as the bridge would not accommodate the passenger traffic from the lower levels near the water.

The commission considers that should there be a question as to the priority of the railway and street railway tunnels, the latter should have precedence, as the street railway traffic is the greater. Arrangements could be made for the convenient transfer of passengers between the cars and trains at North Sydney until the completion of the railway tunnel.

Civil Service Examination Questions for Civil Engineers.

The questions listed below were used by the U. S. Civil Service Commission in examinations for the positions of "Civil Engineer and Superintendent of Construction" and "Civil Engineer and Draftsman," held, respectively, on May 12-13, and April 14-15, 1909.

Civil Engineer and Superintendent of Construction.

The examination period was two days of seven hours each. The subjects and relative weights were as follows:

Mathematics	15
Theory and Practice of Surveying	20
Design and Construction	40
Experience	25
Total weight	100

MATHEMATICS.

(Answer any three of the following questions.)

1. What load per lineal foot should a beam 15 ft. between supports and 3 ins. × 12 ins. in section carry? Bearing power of timber, 7,500 lbs. per sq. in.; factor of safety, 6.

2. A bracket, each arm 18 ins. long, is fastened to the wall with two screws at top and bottom. What would be the stress on the diagonal and on each of the rivets due to a load of 20 lbs. at outer end, neglecting friction? What modification would be required if friction were taken into account?

3. A B C and a b c are two equilateral triangles in parallel planes 12 ins. apart, the sides are 20 and 3 ins, respectively. Projection of a b and b c on plane of A B C are 3 ins. and 1½ ins. from A B and B C. Find solidity of figure and length of sides aA, bB and cC to the nearest 1/10 of an inch.

4. A cast-iron hollow column 16 ft. high and with 6-in. internal diameter supports a dead load of 30,000 lbs. and live load of 20,000 lbs.; factor of safety for dead load, 10; for live load, 15; crushing strength of cast iron, 84,000 lbs. per sq. in. Find thickness to nearest 1/10 of an inch by Gordon's formula:

$$\frac{P}{A} = \frac{S}{1 + \frac{l^2}{Kd^2}}$$

K for cast iron = 800.
r = 3⅓ ins.

THEORY AND PRACTICE OF SURVEYING.

1. (a) What instruments are used in land surveying? (b) What factors determine the accuracy of a survey of this kind?

2. (a) How are instrumental errors avoided in a transit survey? (b) Describe two methods of making a topographical survey with the use of an engineer's transit and stadia rod.

3. (a) What survey should be made preliminary to the construction of water-works for a small town? (b) State concisely the methods of establishing line and grades for a sewer pipe line.

4. (a) Give two methods of locating a simple railway curve. (b) What would be the maximum curve for a freight spur track of standard gage?

5. (a) How would you determine a true meridian at any point by an observation on a circumpolar star? (b) What are the different methods of determining the altitude of mountains and which is the most correct?

DESIGN AND CONSTRUCTION.

(Make all sketches on a scale of ¾-in. to 1 ft.)

1. (a) Make a sketch in detail showing section and plan for a box-frame window in a 13-in. brick wall. (b) Make a sketch showing how floor timber is framed around a brick chimney.

2. (a) Give the proportions of the various materials used and state how these are mixed in making good concrete. (b) Give brief definition of the following terms: "Bond Stone," "Ashlar," "Template," "Skewback," "Wall Plate," "Relieving Arch," "Valley Rafter," "Hip Rafter," "Ridge Timber" and "Collar Beam."

3. (a) State briefly what precaution should be observed in the construction of brickwork. (b) How should the connection between old and new brick walls be made?

4. (a) Name three kinds of good framing timber used in this country. (b) Name three varieties of standard roofing slate.

5. (a) In inspecting the erection of structural work, what points should receive especial consideration? (b) How should the connection between a reinforced-concrete girder and a reinforced-concrete column be made?

6. (a) Describe how terra cotta sewer pipe should be laid. (b) Describe how the connection between a water main and house distributing system should be made.

7. (a) Show by sketch how a range boiler should be connected to the water back of a kitchen range and to supply pipe. (b) Describe how the water test to determine the tightness of soil and water pipes in buildings should be made.

8. (a) Describe an air valve for a hot water radiator, and one for a steam radiator. (b) What trimmings are required on steam heating boilers? What is the purpose of an altitude gage on hot-water boilers?

9. (a) Make detail sketch showing two types of gutters suitable for park roads, and give itemized cost per foot. (b) Make detail showing cross-section of highway culvert of sufficient capacity to carry the run-off of a drainage area of two square miles. Maximum annual rainfall, 45 ins.

10. (a) What are the advantages of the enclosed fuse compared with open-link fuse? (b) Describe the proper method of connection for a three-way switch arranged so that the electric lighting on each of two floors can be controlled from either floor.

Civil Engineer and Draftsman.

The subjects and relative weights were as follows:

Civil Engineer	60
Draftsman	40
	100

CIVIL ENGINEER.

Mathematics	20
Care and Use of Instruments and Surveying	30
Design and Construction	25
Experience	25
	100

The examination period for the subjects under the heading "Civil Engineer" was two days of hours and three hours, respectively. The period for work called for under the heading "Draftsman" four hours.

MATHEMATICS.

(Answer any three of the following questions.)

1. A train of 200 tons ascends an incline of 1 in 200 with a speed of 30 mi. per hr. What is the effective horse-power, neglecting friction?

2. A cantilever beam 10 ins. deep projects 12 ft. from a wall, with flanges 4 ins. wide, all metal being ½-in. thick. It has a load of 2,000 lbs., 4 ft. from wall and 4,000 lbs. at outer end, and a uniform load (including weight of beam) of 120 lbs. per lineal foot. Draw figured bending moment and vertical shear diagram, and calculate maximum fiber stress due to these loads.

3. A canal lock rectangular in plan with side slope of 3 ins. to 1 in., has sluices 2 ft. square in the gates. When the lock is full, the plan at water surface is 250 ft. × 40 ft. and the surface is 11 ft. above bottom of lower sluice and 6 ft. above bottom of upper. If both sluices are left open, in what time will equilibrium of flow through the lock be attained?

4. Two equilateral triangles A B C and a b c parallel and 12 ins. apart have sides of 20 ins. and 3 ins., respectively, and the projection of a b c on A B C is a' b' c'. Given that a' b' is 4 ins. from A B, and b' c' is 2 ins. from B C, find solidity of figure and length of one of the edges aA, cC and bB to nearest 1/10-in.

USE AND CARE OF INSTRUMENTS AND SURVEYING.

(Answer any five of the following.)

1. Describe in detail the collimation and bubble adjustment of a wye level.

2. Name the various errors that enter into angular measurement with the transit, and explain how they may be eliminated or minimized.

3. State in detail how you would determine with plane table the position on paper of a point from which those points already plotted are visible.

4. Classify the various sources of error in leveling work and describe briefly any three of them.

5. What are contour lines? How may data be obtained for their delineation on the map? What condition do correctly laid down contour lines fulfill?

6. What is meant by mean velocity of a stream? In how many ways may this be obtained, and under what conditions are each to be preferred?

DESIGN AND CONSTRUCTION.

Write a thesis on one of the following subjects, illustrating by pen and ink sketch whenever it is thought desirable to shorten description or make text clearer.

1. Reinforced Concrete Construction: Present Condition and Future Possibilities.

2. Steel Construction: Improvement Effected During the Last 50 Years.

3. Panama Lock Canal versus Sea Level Type.

DRAFTSMAN.

A sketch of elevation and of natural and artificial features is given to put in 20-ft. contour and make complete map, and make tracing of the same.

A COAL MINE EXPLOSION at Mansfield, Prussia, July 20, killed 16 miners.

An explosion in the Mines de Singles at Issoire, France, July 26, caused a fall of rock which buried many of the miners, of whom twelve were killed.

An explosion in a coal mine at Belmez, Spain, July 12, is reported to have killed 17 miners.

THE COLLAPSE OF A BUILDING in St. Petersburg, Russia, July 23, killed 17 workmen and injured several others. The building was a six-story structure in course of construction.

THE BURSTING OF A TWELVE-POUNDER gun on the Japanese battleship "Asahi" July 25 killed four men and wounded five others. The explosion occurred during target practice at Ise Bay.

AEROPLANE FLIGHTS.—Louis Bleriot crossed the English Channel with a small monoplane flyer on July 25, winning a prize of $5,000 offered by the London "Daily Mail" for the first aeroplane flight across the Channel. The cliffs near Calais were left at about 4.30 a. m. and a landing was made near Dover at 4.55. The distance of 21 miles was covered at an average speed of about 50 mi. per hr. and at an average height of 250 ft. above the sea. The machine is much like the Antoinette monoplane, with which Hubert Latham made an unsuccessful attempt to cross the Channel on July 19. It is, however, much smaller than the Latham machine, being only 20 ft. across the main planes.

Hubert Latham made a second attempt to cross the English Channel, on July 27, but his engine stopped when within a couple of miles of Dover and his flyer settled into the sea. He and his machine were picked up by British and French torpedo boats.

Orville Wright, on July 27, completed the official

endurance test of the flyer which the Wright Brothers are under contract to furnish the U. S. Army Signal Corps and at the same time established a world's record for sustained aeroplane flight with a passenger. With Lieut. F. P. Lahm the drill grounds at Fort Meyer, Va., were circled 77½ times in 1 hr., 12 min., 36 sec. The best previous similar record, 1 hr., 9 min., 31 sec., was made by Wilbur Wright at Le Mans, France, a year ago. A height of some 50 ft. was held to during this latest flight, though 125 ft. was reached at one time.

THE ANTOINETTE AEROPLANE, which with Hubert Latham tried to cross the English Channel on July 19 and 27, is sometimes called the Lebavasseur Monoplane, after the designer. It has a long boat-like body from the upper forward part of which extends the main supporting plane much like a pair of stiff wings. A single propeller is mounted at the front of the body and back of this is the engine. The operator sits in a cock-pit just behind the main plane. At the rear of the body are vertical fins, two vertical rudders and a horizontal rudder. The control of the rudders is by vertical side hand-wheels just outside the cock-pit, while the engine is controlled by a smaller hand wheel in front of the operator. The under frame consists of two wheels and a runner. The latter is intended to take the first shocks of landing. The performance of the engine used on this type of machine was given, with others, in Engineering News, June 17, p. 676.

A PROPOSED NEW BUILDING CODE for New York City, passed by the Board of Aldermen, as noted in our issues of July 15 and 22, was vetoed by the Mayor after a public hearing. The Mayor criticized the clauses giving large discretionary power to the Superintendent of Buildings (head of the administration of the law in a borough of the city), and suggested also that the right of appeal from this official's decisions should apply not only to decisions adverse to an applicant, but also to favorable decisions, in order that the public interest may be safeguarded. He suggested altering a clause which fixes the least thickness of brick walls at 12 ins., so as to permit 8-in. walls for dwelling-houses, in response to a plea from real estate men of the Brooklyn section. He objected to the limitation of height on reinforced-concrete buildings. He criticized the restrictions on cinder-concrete fireproofing, and stated that inasmuch as no test data were presented on which to base allowable stresses or proper specifications for this material, tests should be made before the ordinance is drawn. He therefore directed Mr. N. P. Lewis, Chief Engineer of the Board of Estimate and Apportionment,

to conduct experiments and prepare accurate stress tables and data showing what is a dangerous percentage of unburned coal in cinder concrete.

Finally, he criticized the clause which permits shingle roofs, because of their danger in spreading fire, which had been dwelt on rather forcibly by representatives of the Board of Fire Underwriters.

The measure having passed the Aldermen by a narrow vote (40 to 38), there is no prospect of being able to pass it over the veto. We have commented editorially upon the code on another page.

A 20-IN. WATER MAIN BURST July 18 at Rochester, N. Y., and the escaping water undermined 30 ft. of the tracks of the New York Central & Hudson River R. R., interrupting all freight traffic for one day. At the point where the main, which was the property of the Rochester & Lake Ontario Water Co., passes under the tracks it is about 7 ft. below the surface.

A 16-in. main belonging to the same company burst on the same day near the plant of the Standard Sewer Pipe Co. on Lexington Ave., Rochester.

A CLOUDBURST AT DULUTH, MINN., July 21, flooded many of the streets to a depth of 3 ft. Two children are reported drowned. The street car service was temporarily disabled and about 20 houses near creeks in the suburbs were washed away.

Floods in Wisconsin in the vicinity of Ashland during the past week did an immense amount of damage to railways and other property. Six bridges across the Marengo River were wrecked by the flood.

A WOODEN HIGHWAY BRIDGE WAS BURNED July 20 at Metuchen, N. J. The bridge carried Middlesex Ave. across the tracks of the Port Reading R. R. Reports state that fire was started by sparks from a locomotive. The gas main that supplies Metuchen fell with the bridge, cutting off the town's gas supply.

A WASHOUT WRECKED A PASSENGER TRAIN on the Wabash R. R., July 24, at Hulls Point, Mo. Six persons were killed and 50 others injured. The Missouri River, which was reported 100 ft. distant from the track at 7 P. M., had so eaten into the bank that three hours later the track was washed out for several hundred feet. At 10 P. M. the wrecked train, No. 4, bound for St. Louis, struck the washout, and more than 600 ft. of track gave way. The engine, baggage car and three sleepers were thrown into the water and reports state that the persons killed were probably drowned.

THE PHILADELPHIA BUILDING COLLAPSE at the corner of 11th and Market Sts. on July 15 (Eng. News, July 22, 1909, p. 107), has been investigated by a coroner's jury. The verdict was that the collapse was due "to the pulling out of joists, by vibration, due to concealed defects." This, of course, exonerates any one from direct responsibility for the accident, but does not explain the cause. The testimony did little to clear up the conditions prior to the fall, although there was a marked attempt on the part of a number of the witnesses to throw the blame on the carpenters' or on the steel foreman, both of whom were killed in the collapse. It was shown, however, that the building was much more unstable than outward examination indicated, and that remodeling was an extremely dangerous procedure. On account of the lightness of the floors and the insecurity of the joist foundations in the walls, the strain incident to shoring was very hazardous, although such was not known certainly to have been the case when the work was started. It is thought that the accident will bring about more stringent building regulations in Philadelphia, especially as regards reconstruction.

THE CITY OF GALVESTON, TEX., was hit, on July 21, by a severe storm somewhat similar to the devastating hurricane of 1900, but, thanks to the protection afforded by the sea-wall and other works built after the previous storm, passed through the ordeal in comparative safety. Some 23 people were killed all along the southern coast of Texas, where the storm raged, and some $800,000 worth of property was destroyed, but this is small damage compared to the thousands of lives and millions of dollars lost in 1900. The hurricane swept up from the Gulf of Mexico and drove the waters of Galveston Bay up against the sea-wall that had been built to resist just such an attack. Some of the water washed over the crest of the wall and flooded a portion of the city, but this was a small proportion of that which might have washed in had not the sea-wall been built. The wind attained a velocity of 68 mi. per hr., against a possible 120 mi. in the previous storm, when the anemometers broke at about 100 miles per hour. The hurricane caused most of its damage at the other parts of the state, going far up into the northwestern part. An interesting feature of the storm were the warnings sent out in advance by the U. S. Weather Bureau, by heeding which a number of people living or working near the shore were able to get back into safer country.

A BREAK IN THE WELLAND CANAL at Lock No. 17, on July 12, held up traffic through the canal for about two weeks. Banks on both sides of the canal were washed away for a considerable distance.

THE NUMBER OF IMMIGRANTS admitted at the port of New York during the fiscal year ending June 30, 1907, was 1,004,756 out of a total of 1,285,349 admitted to the United States. In the following year this city received 585,970 out of a total of 782,870. A recent study on the distribution of immigrants based on figures from 1899 and 1900 shows that within a period averaging six months after their arrival at New York City not less than 107,100 out of 134,000 aliens left for other parts of the country.

COOPERATION IN THE CONSERVATION OF NATural resources on the part of the railways of the country has been arranged for by the Joint Committee on Conservation (43 Wyatt Building, Washington, D. C.) and representatives of the American Railway Engineering and Maintenance of Way Association. A plan submitted for the consideration of the railways is now in the hands of Mr. A. S. Baldwin, Chief Engineer of the Illinois Central R. R. Co., who is chairman of the conservation committee of the association named. Mr. Baldwin has written a letter to the Joint Committee, in which the following paragraph occurs:

On account of the wide areas traversed by the railroads and the great consumption by them of timber and fuel, with their enormous use of iron and steel products, it is believed that the most effectual assistance of the American Railway Engineering and Maintenance of Way Association can be in directing the attention of railroad officials to the excessive wastefulness in the present methods of production of timber and fuel, and the great importance of introducing economies in their use and consumption; also to the importance of economizing in the use of iron and steel products and the possibilities of preservation by protective coatings and otherwise.

From the circular issued by the conservation committee we take the following additional paragraph:

The conservation committee of the railroad association has also asked for advice as to how a reduction in railroad expenses may be brought about by the use of treated ties and for suggestions as to the importance of encouraging in the coal territory served by them the use of by-product ovens. The railroad representatives also want to know what useful varieties of trees can be grown to advantage in each state or group of states, and they ask for information as to how they should be started. They say there is scarcely a railroad in the country that has not some spare pieces of land that might be profitably planted in trees if the railroad officials knew what trees were best suited to the particular locality. The conservation committee has furnished this information. The railroad association, through its conservation committee, has likewise inquired as to the extent of saving in timber through the use of sawed instead of hewn ties. They also make important inquiries as to the prolongation of life of the steel and iron used in their bridges and other constructions. All these inquiries the Committee on Conservation has undertaken to answer, and it will be a matter of only a short time until the suggestions are in the hands of the chief engineers of all the great railroads in the United States.

THE ANTI-BILL-BOARD CRUSADE, carried on by the American Civic Association (Harrisburg, Pa.) and others for some years past, is giving good results here and there, according to statements issued by the association. The Commissioners of the District of Columbia have decreed that

no person shall place, exhibit, maintain or continue any advertisement or poster, except upon such land, houses, buildings, bill-boards, fences or other structures as the Commissioners of the District of Columbia may, in their discretion, authorize in writing for that purpose.

Propositions to erect advertising bill-boards near the recently completed Union Railway Station in Washington have been defeated. At Harrisburg, Pa., an ordinance was passed not long ago, forbidding the erection of any bill-board or advertising sign within 500 ft. of any public building, church, school, charitable institution, park or playground. The legality of the ordinance having been taken into court, the judge decided that the city could not prohibit the erection of bill-boards on private property so long as they were not a menace to health, safety or morals. At the same time, the judge expressed his sympathy with the movement in general as follows:

The aim of this ordinance is the praiseworthy one to advance civic beauty by preventing the unsightly, hideous advertisements which offend the eye, disfigure every thoroughfare and mar the effects of all external comeliness in architecture and in public grounds. We sympathize with this aim, and should be glad to think that in the slow esthetic development of the people under the influence of park commissions, town improvement societies, civic clubs and the like, the time will come when such advertising will be either shamed out of existence or be placed under ban of police regulation on the score of annoyance to the eye as well as of injury to health, safety or morals.

IRRIGATION RATHER THAN NAVIGATION should have first claim to the waters of the Murray River and its tributaries, in Australia, according to arguments recently submitted by Mr. Elwood Mead, M. Am. Soc. C. E., M. Inst. C. E., Chairman and Chief Engineer of the State Rivers and Water Supply Commission of Victoria. His arguments were submitted to the Murray Waters Commission and were based on the best use of the river jointly by the states of New South Wales, Victoria and South Australia. The Murray is the largest river on the continent of Australia. Including the Darling, the stream is navigable for nearly 2,600 miles in winter. In summer the river has never been navigable, and can be made so only by the construction of locks. Locks have been given serious consideration in the past. Mr. Mead pointed out, in the course of his argument, that the total commercial interests connected with the navigation of the river for a considerable period of years past had been much less than the value of the water for irrigation purposes. Freight can be moved by other means, and much of the freight which would be produced as a result of irrigation would be far better moved by rail than by water. The total drainage area of the Murray is 414,000 sq. mi., or over 250,000,000 acres. Of this, about one-fifth would be irrigable if water could be provided. Of the irrigable area, approximately 44,000,000 acres is in New South Wales, 4,000,000 in Victoria and 3,000,000 in South Australia. The estimated cost of providing locks for navigation is about $8,000,000. Allowing 6% for interest and maintenance charges, the annual cost of lockage facilities would be $486,000,

which is more than 25% of the average annual value of both imports and exports shipped on the river at Port Adelaide from 1892 to 1901, inclusive, and with the increasing number of railways touching the river this freight will diminish rather than increase in the future.

Mr. Mead suggests that the three states involved enter into an agreement for developing irrigation works regardless of their effect upon navigation. The agreement should be as simple as possible. The shares of New South Wales and Victoria should depend upon their proportionate contribution to the stream flow, but the actual volume of water available for each state should be left to the regulation of a commission.

HOW TO CONSTRUCT A DOG POUND in accordance with engineering and sanitary principles, may be learned, at least in part, from an interesting illustrated article published in "Denver Municipal Facts" of July 10. The article describes such a pound recently constructed in that city. The building used for this purpose is a frame structure about 20 × 70 ft. in plan, containing separate compartments for 50 dogs, ranged along a

central aisle which affords opportunity for an inspection by seekers after lost pets. For the smaller dogs each compartment is 22 ins. wide and 48 ins. long, while for the larger ones 5 ins. of extra width is provided. The compartments have concrete floors sloping toward a drainage channel at the front, for convenience in washing the whole compartment by means of hose. To give the dogs something more comfortable than a concrete floor to lie upon, there is provided in each compartment a hinged wooden platform a few inches above the floor which can be raised and folded back. Unclaimed dogs are destroyed in a death chamber by means of sulphurous gas.

EXPLOSIONS OF COAL DUST AND GAS have not caused the loss of a single life during the past 18 years in the coal mines of the United States Coal & Coke Co. The precautionary measures adopted in the mines at Gary, W. Va., are outlined as follows in an article by John S. Walker, Jr., published in the June issue of "Mine and Quarry," house organ of the Sullivan Machinery Co.:

At Gary, all the mines are supplied with a carefully drawn set of rules, regarding ventilating and sanitary conditions. These are printed in seven or eight languages in large type, and posted in conspicuous places. Particular attention is called to the necessity for careful handling of powder. It is required that not more than a certain number of men shall work in any one air current, and that the current shall not fall below a stipulated velocity or a quantity of 10,000 cu. ft. per minute at any point throughout the entire mine workings.

The mine foremen, assistant mine foremen, and minor officials are paid premiums each month during which no one under their jurisdiction is seriously injured. Since the adoption of this method, accidents of all classes have been reduced more than one-half. Premiums are also paid to the superintendents who keep their plants in the best and neatest order. All mine officials are required to pass a physical and mental examination as to their eyesight, hearing, and reasonable discretionary powers, before appointment to duty. In the main office at Gary a set of rescue apparatus is installed for use at the various mines in case of emergency.

All the coal in these mines is undercut before being shot. No shooting from the solid is permitted, and men are employed to see that the coal is properly mined before shooting.

ADVERTISEMENTS FOR ENGINEERS AND OTHER municipal officials are common in Great Britain, as has been noted from time to time in these columns. The following solicitation for applications for the appointment of surveyor of highways for the Holsworthy Rural District Council will perhaps interest many of our readers:

The district comprises 21 parishes, with about 32 miles of main roads and 247 miles of district roads.

The salary will be £120 per annum, to include all out-of-pocket expenses, except stationery and postage.

The person appointed, who will be required to take up his duties on the 29th September next, must have a good practical knowledge of roadmaking, and be competent to properly supervise the working of the steam roller and the roadmen in the Council's employ.

He will be required to devote the whole of his time to the duties of the office, to keep the necessary books and accounts applicable thereto, reside at such place as shall be approved by the Council, and to provide his own means of locomotion.

Approved security in the sum of £100 will be required, and the appointment will be subject to the approval of the County Council, and terminable by three months' notice on either side.

Applications, in candidates' own handwriting, stating age (which must be between 25 and 50 years) and present and previous occupations, accompanied by copies of not more than three testimonials of recent date, to be sent to me on or before TUESDAY, the 27th day of July next, endorsed "Surveyor of Highways."

Canvassing the Councillors is strictly prohibited, and will be deemed a disqualification.

By order,
CLAUDE KINSMAN,
Clerk to the Council.

THE DECREASE IN GOLD PRODUCTION in Alaska in 1907 and 1908 is stated, by the U. S. Geological Survey, not to indicate approaching exhaustion of the gold in this region. The decrease is due to labor troubles and temporary lack of adequate water supply. The development of the region is discussed in Bulletin 379, of the Survey. From this it appears that preparations have been made that will ensure a heavy production in the future.

Through the completion of the Tanana Valley Ry., a 50-mile narrow-gage line, and through the construction of wagon roads, heavy loads can be laid down conveniently at the workings on all creeks of importance in the Fairbanks district. Freight rates which were 5 cts. per lb. in winter and 25 cts. in summer have been reduced to a few cents per pound in summer for the most remote points. The region has been in quick communication for several years with the outside world by means of the government telegraph system and during 1908 additional service was rendered available by the installation at Fairbanks of a Government wireless station. Foundries and machine shops have been established in Fairbanks. These are excellently equipped and well directed. Much machinery that is especially adapted to conditions in the district has been devised and entirely constructed in these local shops.

The weather permits common sluicing for a period of 150 days, at the most. To lengthen the production period, an attempt at winter sluicing was made in 1907-8 on Ester Creek. Water was warmed by the exhaust from the hoisting and pumping engines and pumped to the sluice boxes and sluicing was continued until January. This experiment was satisfactory and several operators are preparing for winter sluicing during 1909.

WORK ON GATUN DAM SPILLWAY.—The north section of the floor of Gatun Dam Spillway was completed on June 30, when the last of 480 concrete monoliths was laid. The laying of this concrete was begun on March 17, and 74 working days were spent on it, making no allowance for the frequent rains of June. In this time about 30,000 cu. yds. of concrete were laid, an average of over 400 cu. yds. a day.

The spillway at Gatun is being constructed in three sections—the entrance or opening on the south side of the dam, the concrete dam which will close the mouth of the channel and on which the regulating works will be constructed, and the channel below the concrete dam, through which water will waste in the Chagres River. It is the floor of this channel below the concrete dam that has been completed. The concrete was laid in the monoliths, each 30 ft. long and 20 ft. wide, varying in thickness from four feet at the upstream or south end to one foot at the downstream end. To allow for shrinkage and prevent cracking, the monoliths were laid alternately, that is, each one was allowed to dry before another was laid against it. The section completed is 960 ft. long and 300 ft. wide.

Work on the walls has already begun. They will rise 20 ft. above the floor, into which they will be keyed by a mortise and tenon joint. They will be 8 ft. thick at the base and 3 ft. at the top, the tapering being accomplished by a 1 to 10 slope on the face of the wall and by four steps at the back. Like the floor, the walls will be built in monoliths laid alternately.

The work in the spillway has made better progress than was anticipated, due to the fact that the concrete mixing and handling plant has worked satisfactorily from the beginning.—"Canal Record," July 7.

AN EXPERIMENTAL WATER PURIFICATION plant for Minneapolis has been recommended in a majority report (17 of 21 members) of the Pure Water Commission appointed some weeks ago by the Common Council at the instance of a number of commercial, professional and social organizations of the city of Minneapolis. After reviewing the possibilities of a new water-supply from artesian wells, Lake Superior and Mille Lacs, the Commission recommends that the city continue the use of the Mississippi River, but that purification works of some sort be established. The Commission believes it desirable to make studies to determine what chemical agent should be used, whether such agent should be employed with or without filtration, and, in case of filtration, whether double slow-sand filtration or mechanical filtration should be employed, in order to meet the varying conditions of different seasons of the year. The Pure Water Commission urges the City Council to appoint a Minneapolis Water Commission, to consist (1) of five persons to serve without pay jointly with (2) the Water Committee of the City Council. It also recommends that the City Council, on recommendation of the proposed commission, appoint a consulting engineer, an engineer of construction, and a chemist and bacteriologist, together with necessary assistants; and that an experimental purification plant be built at a cost of $25,000 for construction and equipment. It is suggested that the experimental plant be operated for a full year; that subsequently plans based on the results of the studies be made for a purification plant; and that such a plant be built at the order of the City Council under the direction of the proposed water commission.

Personals.

Mr. Wm. V. Alford, Chief Engineer of the Amazon & Pacific Ry. of Peru, who has been spending some months in the United States on leave of absence, has returned to Peru.

Mr. Edmund M. Blake has resigned his position as Manager of the Idaho Irrigation Co., Ltd., with headquarters at Richfield, Idaho, and has opened an office as a consulting engineer in the Overland Bldg., Boise, Idaho.

Mr. James C. Irwin, M. Am. Soc. C. E., recently Office Engineer for the New York Central & Hudson River R. R., at New York City, has been appointed Chief Engineer of the Rutland R. R., with headquarters at Rutland, Vt., to succeed Mr. Geo. L. Moore, resigned.

Mr. H. R. Robbins, M. Am. Inst. M. E., formerly with the Coilbran-Bostwick Development Co., of Seoul, and the Manchu Syndicate, Ltd., of London, has been appointed Managing Engineer for the Colonial Gold Mining Co., and has taken up his residence at Keremos, B. C.

Mr. Frank Barber, of Toronto, Ont., Engineer for the County of York, and Mr. C. R. Young, Assoc. M. Can. Soc. C. E., lecturer in applied mechanics at the University of Toronto, have formed a partnership as bridge and structural engineers under the firm name of Barber & Young, with offices at 57 Adelaide St., East, Toronto, Ont.

Obituary.

George A. Casseday, Bridge Engineer of the Great Northern Ry., died July 20 at St. Joseph's Hospital, St. Paul, Minn., aged 36 years. Mr. Casseday had been in the service of the Great Northern Ry. since April, 1895, when he entered the bridge department as a draftsman. He has been at the head of that department as Bridge Engineer since March, 1903, and many important structures on this railway as they exist to-day were designed and erected under his supervision.

Robert Pitcairn, formerly Resident Assistant to the President of the Pennsylvania R. R., at Pittsburg, Pa., died July 25 at his home in that city. Mr. Pitcairn was born in Johnstone, Scotland, in 1836, came to this country with his parents when a young boy and in 1853 entered the service of the Pennsylvania R. R., as a telegraph operator at Duncansville, Pa. He became Superintendent of the middle division in 1861 and four years later succeeded Mr. Andrew Carnegie as Superintendent of the Pittsburg division. He was made Assistant to the President Jan. 1, 1902, and was retired four years later upon attaining the age of 70 years. Since his retirement, Mr. Pitcairn had held the honorary position of president of the sinking fund commission. He is survived by his wife and four children.

Engineering Societies.

COMING MEETINGS.

NATIONAL IRRIGATION CONGRESS.
Aug. 9-14. Annual meeting at Spokane, Wash. Secy., B. A. Fowler, Phoenix, Ariz.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION.
Aug. 10-12. Annual convention at Detroit, Mich. Secy., J. D. Farasey, E. 37th St. & Erie R. R., Cleveland, Ohio.

LEAGUE OF AMERICAN MUNICIPALITIES.
Aug. 25-27. Annual convention at Montreal, Can. Secy., John MacVicar, Des Moines, Iowa.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
Aug. 31-Sept. 2. Annual meeting at Briarcliff Manor, N. Y. Secy., D. L. Huntington, Spokane, Wash.

TRAVELING ENGINEERS' ASSOCIATION.
Sept. 7-10. Annual convention at Denver, Colo. Secy., W. O. Thompson, N. Y. C. Car Shops, East Buffalo, N. Y.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Sept. 8-10. Annual convention at New York City. Secy., Willard Kent, 715 Tremont Temple, Boston, Mass.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Sept. 14-16. Annual convention at Atlantic City, N. J. Secy., Frank P. Foster, Corning, N. Y.

MICHIGAN GAS ASSOCIATION.
Sept. 14-17. Annual meeting on board steamer sailing from Detroit, Mich. Secy., A. P. Ewing, Gas Office Bldg., Detroit, Mich.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Sept. 16-Oct. 12. Annual convention and excursion on special train starting at Chicago, Ill. Secy., R. W. Raymond, 29 W. 39th St., New York City.

AMERICAN STREET & INTERURBAN RAILWAY ASSOCIATION.
Oct. 4-8. Annual convention at Denver, Colo. Secy., Bernard V. Swenson, 29 W. 39th St., New York City.

RAILWAY SIGNAL ASSOCIATION.
Oct. 12-14. Annual convention at Louisville, Ky Secy., C. C. Rosenberg, Bethlehem, Pa.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 19. Annual convention at Jacksonville, Fla. Secy., S. F. Patterson, Boston & Maine R. R., Concord, N. H.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Oct. 19-22. Annual convention at Richmond, Va. Secy., Chas. O. Probst, Columbus, Ohio.

AMERICAN GAS INSTITUTE.
Oct. 20. Annual meeting at Detroit, Mich. Secy., A. B. Beadle, 29 W. 39th St., New York City.

NATIONAL MUNICIPAL LEAGUE.—The annual meeting will be held in Cincinnati, Ohio, Nov. 15-18. The secretary is Mr. Clinton Rogers Woodruff, North American Bldg., Philadelphia, Pa.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.—The 21st annual convention will be held at Washington, D. C. The date set for this meeting is Oct. 12, but the secretary, Mr. Wm. H. Connolly, of Washington, D. C., states that in all probability it will be changed to Nov. 16.

INSTITUTION OF COUNTY AND MUNICIPAL ENGINEERS.—The British organization, known heretofore by the cumbersome title of "Incorporated Association of Municipal and County Engineers" has lightened its burden slightly by changing its title to "The Institution of County and Municipal Engineers." The real choice of the organization was "The Institution of Municipal and County Engineers," but in attempting to register this title with the British Board of Trade an obstacle was met in the way of a strenuous objection from the Institution of Civil Engineers, which claimed that the name first selected would be confused with its own, so the name stated above was decided upon.